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THE INFLUENCE OF OBSTACLES ON ANTI-ARMOR WEAPON SYSTEM EFFECTIVENESS

BY

BOYD A. JONES
LTC, ENGINEER

9 JUNE 1983

US ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013

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The basic question is not if obstacles increase defending anti-armor weapon system effectiveness; they do; but how much that effectiveness is increased and what should be done to capitalize on that fact. Past studies have proven increased effectiveness; however, the models used had deficiencies: a total battle simulation was not always conducted; some weapon arrays were incomplete or a standard Training and Doctrine Command scenario was not always used. To support this study, an obstacle array was prepared for a task force defensive sector near Schmidt, Federal Republic of Germany. A battle continued

simulation was conducted using the computer driven Combined Arms Tactical Training Simulation (CATTS) model. Appropriately apportioned defending and attacking forces fought the terrain using the Fulda Scenario. A base case, using no obstacles, and seven (7) additional battles employing ever-increasing numbers of obstacles, of varied types, formed the core of the analysis. Threat and defending force tactics remained constant during all eight simulations. Installation effort and time were played realistically, while logistic availability was assumed based on the author's knowledge of the material and transportation assets actually on site, and the fact that the requirement was well within the 2d Brigade Commander's capability. The simulation results supported the hypothesis that anti-armor weapon system effectiveness is enhanced by an accurately installed and executed obstacle system. Consequently, the United States Army must take action to ensure the timely presence on the battlefield, of substantially more combat engineer assets than are currently available. Considering the fact that this battle was simulated in the area of the enemy supporting attack, utilizing approximately one of two engineer company equivalents in direct support of a four (4) task force brigade, (two initially committed task forces); and the fact that a division deployed on this ground in Europe will initially commit at least 8 of 11 available maneuver battalions, a minimum of three combat engineer battalion equivalents must be committed in the main battle area, forward of Brigade rear boundaries, with a third working the division rear area and a fourth in the corps rear area, immediately behind the division. Therefore, the current engineer force structure, 74% reserve and 26% active component, must be markedly revised to increase the active component. Mobilization and deployment of reserve component engineers, the current plan, cannot be accomplished in a timely manner.

USAWC MILITARY STUDIES PROGRAM

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Individual Study Project

by

Lieutenant Colonel Boyd A. Jones
Engineer

US Army War College
Carlisle Barracks, Pennsylvania 17013
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ABSTRACT

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PREFACE

This Individual Study Project was produced with the cooperation of the CATTS facility at Fort Leavenworth, Kansas. The scope and general methodology were developed by the author with advice from CATTS personnel and from the Directorate of Combat Developments, Fort Belvior, Virginia. The author selected this study based on his past experience; and the fact that no sure method of measuring the combat engineers' contribution to battlefield effectiveness exists. The study model was constrained only by time and the obstacle installation effort available. Threat and defending forces were free to employ any and all tactics and fighting systems.

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CHAPTER I

INTRODUCTION

BACKGROUND

Cost effectiveness analyses have been conducted for virtually every new military weapon system proposed for introduction in the Army inventory during the past fifteen years. Additional studies have determined the need for type systems. Committees have been formed to recommend the priority in which these systems should be developed. Other analyses, too numerous to discuss, have supported these development/procurement decisions. Concurrently, very little has been done to analyze and identify the contribution of non-weapon systems on the battlefield. Examples could be: the worth of an infantry battalion vs an engineer battalion, or a signal battalion, or any other force mix combination one might choose. A follow-up analysis of how many of each are required to do the job has also been neglected. The result is a current force mix designed to reflect the collective capabilities of numerous weapons organic to some units and little more than historic rationale for the organization of other units.

PROBLEM STATEMENT

This study has been designed to take a first step toward identifying the contribution of one non-weapon system, specifically how much installed and properly executed obstacles, located in depth throughout a task force size sector, can enhance the effectiveness of the task force anti-armor weapon systems. Some additional conclusions about the most effort-effective

obstacles and the need for increased numbers of combat engineers on the battlefield may also result.

PROCEDURE

The author opted to tie this analysis to the most credible, timely and available computer simulation model, CATTS. The Fulda Scenario and the array of threat and defending forces portrayed in CATTS were compatible with the tactics and procedures of European forward deployed forces and their potential enemy. A series of eight simulations were conducted using the same terrain, forces, supporting forces and battle conditions. The number and type of obstacles employed was varied from none, in the base case, to a full array using all normally available systems in run seven (7). A comparative analysis of the resulting friendly and enemy armor vehicle and personnel losses in each of the runs, when compared to the type and quantity of obstacles employed, was the data base supporting the conclusions. The enemy vehicle and personnel kills caused by obstacles were discounted in the computation of weapon effectiveness. Design estimates for the type and size of obstacles used have been developed and field tested over a period of ten years by the author and others. Installation times used have likewise been field tested and were further increased to provide a most conservative case. The conclusions were applied against the current disposition of forces in Europe to document the engineer force required for optimum support forward of committed brigade rear boundaries. This result was interpolated to determine the total number of combat engineer forces necessary to support the total division and corps battle, in depth.

ORGANIZATION OF THE PAPER

This study is organized to briefly identify the background, situation, the purpose of the study, procedures used and the results obtained in Chapter I. Chapter II presents the data used to generate the obstacle array; discusses the tactical scenario; lists the assumptions; addresses methodology; and briefly describes the simulation model. The results of the simulation are reported and analysed in Chapter III. Chapter IV presents the study conclusions and recommendations. The appendices and tabs display the supporting estimates, work flow charts and other study documentation.

CHAPTER II

PREPARATION FOR THE ANALYSIS

THE SECTOR

The tactical situation used for this analysis is based on OPORD 20[1] 52d Mechanized Division (Notional) assigned the mission of defending a sector of the Fulda Gap, Federal Republic of Germany. (Appendix 1) Friendly forces are opposed by elements of the notional 24th Combined Arms Army of the Southern Front, using approved threat force doctrine, organization for combat and tactics.[2] (Appendix 2)

The 52d division defended the Main Battle Area with two brigades committed and one in reserve. These brigades were to be subsequently reinforced by additional task forces after completion of the covering force battle. The portion of the battle analysed by this study took place in the sector of Task Force 1-78 Mech., 2d Brigade, 52d Mechanized Division. The simulation terrain is identified on Map 1. The 2d Brigade operations overlay is at Tab A to Map 1. This sector was selected for several reasons. The 2d Brigade was assigned second priority for support by the division. TF 1-78 Mech. was given first priority of support within the 2d Brigade. The terrain is a mix of good and poor armor country laced with good and poor forest trails and two lane roads. Natural obstacles are present, but they do not dominate maneuver. In general TF 1-78 Mech. got a fair share of support, but not enough to skew the results of this study. The battle simulation concluded (forward of the task force rear boundary) before TF 1-78 Mech. was reinforced by TF 1-4 Armor, defending in depth, or

by elements returning from the covering force battle. This decision reduced the number of tactical variables which could have clouded the evaluation of obstacle effectiveness, but did not prejudice the study.

The 2d Brigade 52d (MD) was supported by its normal complement of combat and combat support forces. (Appendix 1) These assets were allocated by division, in priority, to the 3d then 2d Brigade; and within the 2d Brigade to TF 1-78 Mech., then 2-120 Infantry. The TF 1-78 sector, at the forward edge of the MBA (Phase Yellow Line), was twice as large as the 2-120 Infantry sector to the north. (Tab A to Map 1) Consequently, of the five combat engineer platoons (one Co. and one Co.(-)) initially in direct support of second brigade, the author allocated one half of the earthmoving equipment and nine (9) of the available fifteen (15) squads to support TF 1-78 Mech. In addition, TF 1-78 Mech. provided nine (9) infantry squads for obstacle installation prior to the enemy attack at the Inter-Zonal Border (IZB). One M-56 system-capable helicopter and 1 1/2 batteries of artillery were also available to TF 1-78 for obstacle installation, or other missions. (Table 1)

TABLE 1

TASK FORCE 1-78 OBSTACLE INSTALLATION ASSETS

UNIT	ASSETS	TIME AVAILABLE[1]
TF 1-78 MECH	9-Squads	28 Hours
B(-)/52D ENGR BN (MD)	5-Squads 1-Tank Ditch Team	34(+)[2] Hours 34(+)[2] Hours
B(-)/500TH ENGR BN (C)	4-Squads 1-Tank Ditch Team	34(+)[2] Hours 34(+)[2] Hours
52D AVN BN (MD)	1-Helicopter[3]	Dedicated[4]
52D DIVARTY	1 1/2-Batterys	Direct Support

NOTES: 1. See Tabs A-G to Appendix 5 for the obstacle work schedule.

2. Engineer forces continued to install obstacles after the battle reached the TF 1-78 Mech. sector.

3. M-56 Minefield System capable aircraft.

4. Dedicated to the 2d Brigade by Division.

BATTLEFIELD PREPARATION

Several assumptions have been made with respect to battlefield preparation. All are based on standard practice and have been further adjusted on the conservative side. Forty-eight (48) hours of warning time were available prior to the enemy attack across the IZB. Of this total, twelve (12) hours were used to move and position friendly forces. Thirty-six (36) hours remained for battlefield preparation. To further prejudice this study on the conservative side, only twenty-eight (28) of the thirty-six (36) battlefield preparation hours were played. An additional four (4) hours of preparation time was assumed to be available as the covering force battle was fought from the IZB to Phase Line Yellow. During all simulation runs, the enemy forces were arrayed immediately east of the E-70 (north/south autobahn), vicinity north/south grid 48 (Map 1), to conserve computer running time. The covering force battle was assumed; and enemy forces were deployed for an MBA attack. The infantry obstacle installation squads did not start work on any new obstacles after the enemy cross the IZB. Execution of non-reserve obstacles and those retained under TF 1-78 control was accomplished by maneuver forces in contact. All road crater, abatis, tank ditch, bridge, and log obstacles were reinforced with mines.

WEAPON EFFECTIVENESS

The computer simulation displayed all point obstacles as lines and all minefield obstacles as rectangles or convex polygons. The simulation played eleven (11) types of natural and man-made obstacles. A description of the CATTS obstacle sub-module is at Appendix 3.[3] Table 2 shows the relationship between the actual obstacles designed for the simulation, those recognized by the computer and the man hours to reduce each obstacle. An argument can be advanced that the reduction time shown is not realistic in all cases. The author would concur with this judgement. However, while some times are excessive, others are inadequate. On average, the anomalies in this system are acceptable.

TABLE 2

SIMULATION OBSTACLES

DESIGNED STANDARD OBSTACLES	SIMULATION RECOGNIZED OBSTACLES	REDUCTION TIME
A-Abatis	General Mass Obstacle	.1
AC-Deliberate Road Crater	Crater Field	.1
BC-M-180 Road Crater	Crater Field	.1
AB-Single Lane Highway Bridge	Ravine	10.0
BB-Double Lane Highway Bridge	Ravine	10.0
DB-Single Track Railroad Bridge	Ravine	10.0
BM-M-21 Minefield, P_e .5	Minefield	.4
BMD-M-21 Minefield, P_e .75	Minefield	.4
CMA/B/C/D-M-34 Minefield, P_e .5	Minefield	.4
DMA/B/C/D-M-34 Minefield, P_e .75	Minefield	.4
FLM-M-70 Minefield, P_e .5	Minefield	.4

FLMD-M-70 Minefield, P_e .75	Minefield	.4
LO-Log Obstacle	Fixed Wall Barrier	.25
TD-Tank Ditch	Ditch	.3

OTHER OBSTACLES RECOGNIZED BY THE MODEL[2]

None	Lake	4.0
None	Waterway	4.0
None	Concertina Wall	.25
None	Cliff	10.0
None	Terrain	Varies by Type

Note: 1. Manhours per meter required to reduce the obstacle.

2. The concertina wall obstacle was not played. The other natural obstacles were played in the model, but not included in the obstacle plan.

The delay at each of these obstacles is a key determinant in obstacle effectiveness, given that the obstacles are properly positioned, in depth, to support weapons systems. Proper positioning causes an enemy delay in the "target window" of the long- and short-range defending anti-armor weapon systems. This delay allows the crews of defending systems to kill more enemy vehicles, over the period of delay, than would have been possible if the enemy vehicles had proceeded unencumbered along their avenues of attack. Positioning in depth is one key to precluding an enemy force from gaining or regaining their momentum. Depth, in addition, provides the defender with a series of "target windows" throughout most of the effective range of his weapon system. It also provides an equivalent delay during periods of reduced visibility. The actual weapon enhancement is measured by the number of additional kills achieved during the delay periods when compared

with no delay. The enhancement is compounded positively by the fact that more friendly systems survive, during both the short- and long-term battle, for longer periods of time, thus increasing and better concentrating fire power. The short-term battle gain is realized because systems can remain in their general locations and fire longer than would be possible in a battle with the enemy unencumbered by obstacles. The long-term gain is derived because of increased friendly weapon system survivability even without defilade position protection. When systems stay and fight, vulnerable portions of the carrier vehicle aren't exposed for extended periods during maneuver to other fighting positions. The massed fire from more friendly weapons on a more concentrated enemy also precludes efficiency in his ranging and targeting procedures, resulting in more friendly survivors.

STANDARD OBSTACLES

The design of the obstacles employed during this simulation and the installation effort required for each were derived from the 23d Engineer Battalion Obstacle Data[4] at Appendix 4. This source deals only with standard obstacles, standard in terms of design, effort to install, materials required and effective size. The standard is always the smallest feasible obstacle, e.g., a one-lane road crater or a 100 x 58 meter minefield. Whenever a larger obstacle is required multiples of the standard are used, e.g., four (4) standard 100 x 58 meter minefields could become one (1) 400 x 58 meter or one (1) 200 x 116 meter minefield, etc. Standard obstacles cannot, however, be utilized for every task. Structures such as highway and railroad bridges, dams, locks and tunnels require individually calculated and designed obstacles. Bridges were the only obstacles in this study so encumbered. The assumption was made to use some number of standard abatis

obstacles to target each bridge. This decision was reasonable since the demolitions in the abatis standard obstacle are easily adapted to a bridge target; and the installation time allowed for an abatis is sufficient for installation of the smallest type of bridge obstacle.

An additional conservative feature of the obstacle installation process was the two hour travel time allowed for each squad between completion of one task and the start of another. The confined battle area gamed can easily be traveled from one extreme to another in about thirty (30) minutes. During an actual battle, obstacle installation will be nearly nonstop. However, the average nonproductive squad time per day in this simulation was nearly 7.4 hours; 8 hours for the equipment teams. After contact was made between elements of TF 1-78 Mech. and the enemy force, obstacle installation work effort was reduced to ten (10) hours during each twenty-four (24) hour period with no additional provision for travel, maintenance or rest time. Map 2 and Appendix 5 shows the obstacle plan for TF 1-78 Mech. Appendix 5 identifies the target number, location, short tons of material required, installation effort, unit assigned to install and necessary computer data. The pertinent information from Appendix 5 is summarized in Table 3. Totals for columns five (5) through nine (9) respectively are short tons, squad hours, equipment hours, helicopter hours and battery hours. Tabs A through H to Appendix 5 graphically display the efforts of all obstacle installation units, over time. Tab A provides the assumptions and Tabs B through H relate to computer runs 1 through 7 respectively. Planning for and installation of obstacles was stopped at the north/south 35 NB grid in the gamed sector. This battle limit was far enough west to ensure that enemy forces had fought to a point at least 3000 meters west of the Schlitz built up obstacle.

TABLE 3

TF 1-78 MECH OBSTACLE PLAN SUMMARY

NUMBER OF PLANNED OBSTACLES 110

NUMBER OF STANDARD OBSTACLES 291

1 Number	2 Designator	3 Description	4 No. Std. Obs.	5 T	6 SH	7 EH	8 HH	9 BH
10 ea	A	Abatis	11 ea	3.08	22	-	-	-
7 ea	AB	Single Lane Highway Bridge	14 ea	3.92	28	-	-	-
10 ea	AC	Deliberate Road Crater	27 ea	8.91	54	-	-	-
6 ea	BB	Double Lane Highway Bridge	24 ea	6.72	48	-	-	-
17 ea	BC	M-180 Road Crater	63 ea	13.23	31.5	-	-	-
10 ea	BM	M-21 Minefield (P_e .5)	50 ea	25.0	168	-	-	-
1 ea	BMD	M-21 Minefield (P_e .75)	5 ea	3.65	27.5	-	-	-
13 ea	TD	Tank Ditch	38 ea	4.94	26	39		
2 ea	CMA	M-34 Minefield 400m (P_e .5)	2 ea	.30	-	-	.5	
4 ea	CMB	M-34 Minefield 600m (P_e .5)	4 ea	1.12	-	-	1.0	-
2 ea	DB	Single Track Railroad Bridge	12 ea	3.36	24	-	-	-
1 ea	DM	M-34 Minefield 200m (P_e .75)	1 ea	.15	-	-	.25	-
3 ea	DMA	M-34 Minefield 400m (P_e .75)	3 [illegible]	.84	-	-	.75	-
3 ea	DMB	M-34 Minefield 600m (P_e .75)	3 ea	1.5	-	-	1.5	-
1 ea	DMC	M-34 Minefield 800m (P_e .75)	1 ea	.63	-	-	.5	-
8 ea	FIM	M-70 Minefield 200^2 (P_e .5)	19 ea	6.2	-	-	-	1.36

	1	2	3	4	5	6	7	8	9
	Number	Designator	Description	No. Std. Obs.	T	SH	EH	HH	BH
	3 ea	FIMD	M-70 Minefield $200m^2$ (P_e .5)	5 ea	3.42	-	-	-	.51
	9 ea	IO	Log Obstacle	9 ea	1.44	36	-	-	-
TOTALS	110 ea			291 ea	88.41	465	39	4.5	1.87

THE SIMULATION

Computer runs and the type of obstacles employed during each are identified in Table 4.

TABLE 4

OBSTACLES BY COMPUTER RUN

COMPUTER RUN	TYPES OF OBSTACLES[1]	TOTAL NUMBER OF OBSTACLES
Base Case	None	0
1	AB-AC-BB-DB	25
2	AB-AC-BB-BC-DB	42
3	AB-AC-BB-BC-DB-IO	51
4	A-AB-AC-BB-BC-DB-IO-TD	74
5	A-AB-AC-BB-BC-BM-BMD-DB-IO-TD	85
6	A-AB-AC-BB-BC-BM-BMD-CMA-CMB-DB-DM-DMA-DMB-DMC-IO-TD	99
7	A-AB-AC-BB-BC-BM-BMD-CMA-CMB-DB-DM-DMA-DMB-DMC-FLM-FLMD-IO-TD	110

NOTE: 1. Abbreviations are explained in Appendix 4.

Obstacles were assigned to computer runs based generally on the amount of effort necessary to install. An exception to this rule was made for minefields, normally the most effective type of obstacle. Hand emplaced minefields were added in run five (5) and the dynamically delivered minefields in runs six (6) and seven (7). Weapon system effectiveness should markedly increase between the base case and run one (1) and again between run four (4) and run five (5). Significant increase should also be noted between runs five (5) and six (6), and six (6) and seven (7). Analysis of this total effort to install versus effectiveness of obstacles should be a key to the design of more effective future obstacles.

A group of officers from the Combined Arms Center initialized the threat force and another group the TF 1-78 Mech. forces in accordance with current threat and US doctrine. The enemy forces objective was located about five (5) kilometers west of Schlitz, vicinity N/S grid line 35. Six avenues of approach within the defending force sector were used by the attacking enemy. Each computer run required between eight (8) and twelve (12) hours of real time to accomplish. Based on the excessive amount of time required for the entire simulation, system priority and potential problems inherent in any computer model, the following priorities were assigned: Base Case, Run 7, Run 5, Run 3, Run 1, Run 6, Run 4, and Run 2.

Obstacle design was not critical to this study becuase the model cannot differentiate between a more or less dense minefield, or a more versus less effective obstacle except in the terms of reference described in Appendix 3 and shown in Table 2. This fact demonstrates the need for a model which will award an advantage for a more versus less effective obstacle as an additional capability.

CHAPTER II

ENDNOTES

1. Combined Arms Center, Fort Leavenworth, Kansas, "OPORD 20 52d Mech Division," Student Issue, Academic Year 1982.

2. Combined Arms Center, Fort Leavenworth, Kansas, "24th Combined Arms Army Southern Front," (Extracts), Student Issue, Academic Year 1982.

3. Combined Arms Center, Fort Leavenworth, Kansas, "Obstacle Sub-Module," CATTS Manual, pages 5-548 to 5-576.

4. 23d Engineer Battalion (AD), "Obstacle Data," FM 5-34 supplement, May 1980.

CHAPTER III

SIMULATION RESULTS AND ANALYSIS

ADDITIONAL CONSTRAINTS

Some additional constraints were imposed during the conduct of this study because of the limited amount of computer time which was ultimately available and some computer mechanical problems. Other changes also became necessary which limited the output of the CATTS simulation. The obstacle sub-module could only store the data for fifty (50) of the one-hundred-ten (110) preplanned obstacles. Of the fifty, only twenty (20) could contain mines or be minefields. Given sufficient time, the sub-module memory could have been purged of data relating to the initial fifty (50) obstacles and reloaded; however, this was not done for two reasons. First, sufficient time was not available. Second such a reload procedure would have caused an anomaly in the desired effectiveness data. Following enemy units would have been able to pass over obstacle-free terrain, negating the impact of obstacle encounters, the associated kills and the requirement to breech or clear them. This action would also have improperly influenced the enhancement data being collected. Gamers were unable to alleviate this problem by increasing the sub-module memory to the one-hundred-ten (110) required. The constraint of twenty (20) obstacles containing mines, or twenty (20) minefields negated the effect of the mines used to reinforce each bridge, ditch, crater, abatis and log obstacle. Reinforced obstacles are more difficult to breech and clear. They add significantly to delay times and consequently to weapon system enhancement. Certainly, the reinforced

obstacles could have been coded as minefields, but the model characteristics would then have made them much more effective than is realistic, and the number of actual minefields gamed would have been reduced accordingly.

A third constraint, which reduced the total number of enemy kills during the simulation, was the decision not to commit the enemy second echelon regiment of the first echelon division to battle. This decision was necessitated because of the fifty (50) obstacle memory limit. Since the limit precluded obstacle installation west of grid line NB38, additional forces committed at or beyond that point (approximately where the second echelon regiment would have been committed) would have rapidly gained momentum and moved over unobstructed terrain to their objectives. This action would have invalidated the battle results already collected. For the same reason, the battle was also stopped in the vicinity of north/south grid line NB38.

Each of these constraints further prejudiced this study on the conservative side. The fifty (50) obstacle limit caused a reduction of thirty-four (34) obstacles (84 preplanned - 50 installed = 34 not used) between grid lines 38 and 48 (Map 2). This fact, combined with the requirement to stop the simulation at grid line 38 versus grid line 35, as originally planned, caused a total of sixty (60) obstacles (34 + 26 planned between grid lines 35 and 38) not to be installed. The resulting 54% reduction in the number of obstacles played, markedly reduced the number of enemy encounters with obstacles during the battle, concurrently reducing the number of enemy systems killed and ultimately, the friendly weapon system enhancement. Another limiting factor was the inability to employ some of the most effective minefield obstacles, those planned west of grid line 38. These obstacles, combined with the increasing effectiveness of TF 1-78 MECH fire

at this point in the battle, could have made the results much more decisive. The inability to play conventional obstacles reinfor[illegible] mines reduced the amount of delay time at each obstacle, thus reducing the number of enemy systems killed by defending weapons. In combination, these unprogramed constraints caused the simulation results to be even more conservative than had been planned by the author. Consequently, the results of this study will be understated by a factor of at least two or three.

The mechanical problems with the computer and the accompanying constraints resulted in fewer simulation runs than had been planned. A base case run, without obstacles, was planned and conducted. Seven (7) additional runs, each adding different kinds of obstacles had been planned, but only three (3) (runs 3, 5 and 7) were actually conducted. This fact caused the loss of data which could have provided some information about the effectiveness of certain types or mixes of obstacles in relation to the amount of effort required to install and execute them. The loss of run one (1), the first with any obstacles, decreased only the amount of obstacle encounter data available. This loss did not impact on the basic study goal, since all effectiveness data was repeated during run seven (7). Run two (2) however, could have provided some information about the effort versus effectiveness relationship of the M-180 road crater. Run four (4) could have provided similar data for tank ditches and run six (6), data on helicopter implaced M-34 minefields. Effectiveness data from the obstacles planned for employment during runs two, four and six was not required to reach a study conclusion.

TIME

The battle simulation was fought from the enemy attack positions, east of north/south grid line NB48, to the vicinity of grid line NB38, a distance

of ten (10) kilometers. Eight of these ten kilometers contained obstacles, although not in the originally planned density. Table 5 shows the times required for each of the simulation runs, and provides some initial insight into the effect of obstacles on an enemy force.

TABLE 5

BATTLE SIMULATION TIMES

	START	FINISH	DURATION	CHANGE
BASE CASE	12:00 Hrs.	16:11 Hrs.	4:11 Hrs.	----
RUN #3	12:00 Hrs.	15:46 Hrs.	3:56 Hrs.	-0:15 Min.
RUN #5	12:00 Hrs.	17:03 Hrs.	5:03 Hrs.	+1:08 Hrs.
RUN #7	12:00 Hrs.	17:03 Hrs.	5:03 Hrs.	----

Note the anomaly between the times recorded for the base case and run three (3). Resolution from the four eliminated runs might have provided some rationale for this fifteen (15) minute reduction in run time when obstacles were added to the simulation. This is a definite problem which defies logic. With the tactics and techniques of the opposing forces and their supporting elements held constant for all runs, the addition of more combat multipliers on one side or the other will have a measurable impact. Therefore, the only logical explanation for the problem (a shorter versus longer battle) is the human element. Controllers and gamers gain experience as they work with any simulation. Their increased efficiency must have reduced the artificial delays recorded in the base case run, causing the anomaly in battle times. Logically, using the results of encounters in run seven (7) and interpolating, run four (4) should have lasted approximately seven (7) minutes longer than the base case run (4:18 vs 3:56). This conclusion is supported by the difference in battle times between runs

three (3) and five (5), one hour and eight minutes (1:08), and an analysis of the obstacles encountered. The run five (5) increase can definitely be attributed to the addition of more effective obstacles. Forty percent more obstacles were planned for run five (5), but actually only fifty (50) were gamed during both runs. Fifty (50) conventional obstacles during run three and forty-three (43) conventional obstacles and seven (7) hand emplaced minefields during run five (5).

The more significant point concerns the fifty-two (52) minute increase in battle time recorded between the base case run and run five (5). The seven (7) minefields added for run five (5) accounted for most of the increase, considering a delay ratio of six (6) for minefields to one (1) for other obstacles (6:1). Any increase in delay time at each obstacle is vital to the increased effectiveness of the weapons covering that obstacle by fire, but is not significant in its own right.

ENCOUNTERS

The measure of overall weapon system enhancement is dependent upon what occurs during all enemy encounters with an obstacle. This simulation documented and recorded an encounter each time an enemy platoon size force entered an obstacle. The encounter terminated when the platoon departed the obstacle. The characteristics of an obstacle encounter are explained in Appendix 3. Table 6 shows the results of the one hundred-thirty-seven (137) obstacle encounters that occurred during simulation run seven (7). Encounters from earlier runs were repeated during run seven (7), changing ony when a minefield obstacle replaced another obstacle in the memory. Therefore, earlier encounters will not be analyzed in terms of enhancement. Their only contribution, because of the fifty (50) obstacle limit, was to reprove the fact that minefields are the most effective type of obstacle.

Of the fifty (50) obstacles employed during run seven (7), only twenty-eight (28) were encountered by some portion of the enemy force, an encounter rate of fifty-six (56) percent. Forty-two (42) enemy platoons made the one hundred-thirty-seven (137) encounters; and was each delayed an average of twenty (20) minutes. The effect of these encounters can be judged by comparing the losses to the enemy force without obstacles to the loses incurred after obstacles were employed (Table 7, Enemy/Friendly Losses). For simplicity's sake, only the base case and run seven (7) are compared. Data for all enemy weapons and personnel are included. Table 7 provides simliar data for the defending forces.

ENHANCEMENT

The results show a considerable increase in enemy losses and a significant reduction in friendly losses when comparing run seven (7), where obstacles were employed, with the base case without obstacles. Obstacles, on average, increased total enemy losses by 197 (twelve (12) percent) and reduced friendly losses by 96 (seventeen (17) percent). Antiarmor weapon systems losses for both sides are compared in Table 8, Causes of Antiarmor Weapon System Losses. The effect of obstacle employment was obvious during run seven (7). Forty-five (45) enemy antiarmor systems were destroyed just by the obstacles, yet the increase in total enemy losses was only fifteen (15). Four (4) less friendly antiarmor systems were lost in run seven (7) than during the base case run. In terms of pure enhancement, the M-113 TOW and the Dragon were the only systems to generate supporting data. TOWs killed three (3) more T-62s with obstacles employed, a three-fold enhancement. Dragons killed one (1) additional BMP and two (2) more BRDMs with obstacles employed, also a three-fold enhancement. The author could not determine if the CATTS model would accept fire commands from defending

TABLE 6

OBSTACLE ENCOUNTERS

OBSTACLES ENCOUNTERED	NUMBER OF ENCOUNTERS	PERSONNEL LOSSES	EQUIPMENT LOSSES	MINUTES OF DELAY	
BM-07	7	30	3-BTR-60 1-BRDM 3-T-62	291	
TD-12	3	0	0	9	
BM-29	9	45	6-BTR-60 1-BRDM 2-T-62	265	
BC-25	15	0	0	93	
BMD-27	5	30	5-BTR-60	53	
TD-18	1	0	0	3	
BB-49	1	0	0	38	
DMBD-45	4	11	1-BTR-60 1-T-62	125	
DM-43	10	39	5-BTR-60 2-T-62	914	
DMA-39	7	26	3-BTR-60 2-T-62	204	
BC-61	1	0	0	2	
BC-99	2	0	0	18	
TD-40	10	0	0	49	
BB-41	2	0	0	10	
AB-57	6	0	0	22	
TD-64	2	0	0	6	
DMB-59	1	3	1-T-62	30	
FLMD-75	10	24	2-BTR-60 2-T-62	141	
FLMD-55	6	27	3-BTR-60 3-T-62	73	
CMA-51	1	1	0	163	
AB-93	6	0	0	31	
TD-88	6	0	0	27	
TD-152	5	0	0	26	
FLM-97	1	3	0	57	
BC-73	2	0	0	13	
AC-153	3	0	0	12	
A-189	3	0	0	9	
DB-141	2	0	0	12	
28 ea.	137 ea.	239 ea.	28-BTR-60s 2-BRDMs 17-T-62s	2696 min.	TOTALS

TABLE 7

ENEMY LOSSES

	INITIAL STRENGTH	BASE CASE LOSSES	RUN 7 LOSSES	CHANGE	PERCENT CHANGE	REMAINING STRENGTH	% LOSS W/O OBS	% LOSS W/ OBS	PERCENT CHANGE
PERSONNEL	2839	502	667	+165	+25%	2172	18%	24%	+6%
BMPs	3	3	3	-0-	-0-	-0-	100%	100%	-0-
BRDMs	24	18	16	-2	-11%	8	75%	67%	-8%
SA-7s	38	2	1	-1	-50%	37	5%	3%	-2%
AKMs	1971	71	75	+4	+5%	1896	4%	4%	-0-
7.62 MGs	84	8	23	+15	+188%	61	10%	27%	+17%
BTR-60s	81	54	63	+9	+14%	18	67%	78%	+11%
RPG-7s	90	34	28	-6	-18%	62	38%	31%	-7%
SPG-9s	9	4	3	-1	-25%	6	44%	33%	-11%
AT-3s	9	6	3	-3	-50%	6	67%	33%	-34%
T-62s	39	13	30	+17	+130%	9	33%	77%	+44%

FRIENDLY LOSSES

	INITIAL STRENGTH	BASE CASE LOSSES	RUN 7 LOSSES	CHANGE	PERCENT CHANGE	REMAINING STRENGTH	% LOSS W/O OBS	% LOSS W/ OBS	PERCENT CHANGE
PERSONNEL	744	400	320	-80	-20%	424	54%	43%	-11%
M-113 TOW	22	16	13	-3	-19%	9	73%	59%	-14%
M-113 A1	88	33	30	-3	-9%	58	38%	34%	-4%
DRAGON	22	19	17	-2	-11%	5	86%	77%	-9%
M-16	442	34	36	+2	+6%	406	8%	8%	-0-
LAW	133	17	22	-5	-23%	111	13%	17%	+4%
TRUCK	11	3	1	-2	-67%	10	27%	9%	-18%
VULCAN	6	4	4	-0-	-0-	2	67%	67%	-0-
M-60 A1	17	14	10	-4	-29%	7	82%	59%	-23%
7.62 MG	34	22	22	-0-	-0-	12	65%	65%	-0-
M-125 A1	9	3	2	-1	-33%	7	33%	22%	-11%
M-109 A1	27	8	0	-8	-100%	27	30%	-0-	-30%

TABLE 8

CAUSES OF ANTIARMOR WEAPON SYSTEM LOSSES

ENEMY

	BMP BASE	BMP 7	BRDM BASE	BRDM 7	BTR-60 BASE	BTR-60 7	RPG-7 BASE	RPG-7 7	AT-3 BASE	AT-3 7	T-62 BASE	T-62 7	
M113 -TOW	1	1	5	5	14	11					1	4	(21 / 21)
DRAGON		1		2	6	6					2	2	(8 / 11)
LAW				1									(0 / 1)
M-60 A1	2	1	9	2	23	9			2	1	3		(39 / 13)
OBSTACLES				2		28						15	(0 / 45)
OTHER			4	4	11	9	34	28	4	2	7	9	(60 / 52)
TOTAL	3	3	18	16	54	63	34	28	6	3	13	30	(128 / 143)

FRIENDLY

	M-113 TOW BASE	M-113 TOW SEVEN	DRAGON BASE	DRAGON SEVEN	LAW BASE	LAW SEVEN	M-60 A1 BASE	M-60 A1 SEVEN	
BMP	1								(1 / 0)
BRDM	3		1	5	6	13			(10 / 18)
BTR-60	5	4	4	8	11	9			(20 / 21)
RPG-7	1		1	1			1		(3 / 1)
AT-3									(0 / 0)
T-62	4	7	13	3			11	8	(28 / 18)
OTHER	2	2					2	2	(4 / 4)
TOTAL	16	13	19	17	17	22	14	10	(66 / 62)

weapon systems, against enemy systems in an obstacle, while the obstacle sub-module was calculating an encounter. If not, enhancement would only be influenced when targets not delayed by an obstacle were engaged, an unsatisfactory situation. Although this limited data must be judged inconclusive, some promising trends appeared. Shorter range weapon systems successfully engaged more enemy antiarmor weapon systems when obstacles were employed. This factor could be extremely important during battles conducted under conditions of reduced visibility. More longer range defending antiarmor weapon systems survived when obstacles were employed. LAWs were the only system to suffer higher losses (22 vs 17) while a total of nine (9) fewer longer range systems were lost. This is significant from the perspective of being able to mass more direct fire, for longer periods of time, on an advancing enemy.

Correction of many of the CATTS model weaknesses uncovered by this study, or design of a new model, is essential to further development of the weapon enhancement concept. Perhaps the most important change should be the ability of the model to accept direct fire engagements against enemy systems while they are encountering obstacles. The ability of the model to accept minefield density and probability of encounter data is also essential. Some minefields could then be made more effective than others. Next in importance would be better definition of what happens to a vehicle encountering an obstacle. Not all mines kill, some merely immobilize the target. CATTS seems to have a characteristic which provides minefields with more lethality than is appropriate, but that's the subject for another study. Even though the results obtained by this limited analysis were not significant, some antiarmor weapon system enhancement was demonstrated, and a trend confirmed. Future studies must continue to pursue the answer to the enhancement question.

CHAPTER III

ENDNOTES

All data in this chapter was derived from the following computer simulation printouts.

1. Combined Arms Center, Fort Leavenworth, Kansas, "Base Case 151611," CATTS, 3 June 1983.

2. Combined Arms Center, Fort Leavenworth, Kansas, "Run Three, 151548," CATTS, 7 June 1983.

3. Combined Arms Center, Fort Leavenworth, Kansas, "Run Five, 151704," CATTS, 6 June 1983.

4. Combined Arms Center, Fort Leavenworth, Kansas, "Run Seven, 151703," CATTS, 6 June 1983.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Analysis of the output data obtained from the CATTS model resulted in several concrete conclusions and other reasonably verifiable trends. The author would, however, caution the casual reader not to use these results as fact. The CATTS obstacle sub-module is still too simplistic to accurately support conclusions about how much defending antiarmor weapon systems are enhanced, in terms of increased enemy kills, by the employment of obstacles, or to game obstacle effects and characteristics properly.

Three conclusions, which have been proven during earlier analyses, were reconfirmed during this study. Enemy losses increase, friendly losses decrease and battle time increases when obstacles are employed. Most of the additional enemy losses during this simulation were caused directly by minefields. The increased battle time was also directly attributable to the delay caused by obstacles at a ratio of about 6:1, minefields to other obstacles. Insufficient data is available to document what caused the reduction in friendly force losses; however, one theory holds some promise. Obstacle delay reduces enemy momentum and causes the small unit encountering the obstacle to temporarily assume a defensive posture. When this occurs, friendly defending forces are better able to concentrate an increased volume of aimed fire on small groups of attackers, while reducing their own vulnerability through more infrequent exposure. Extra time also

leads to better tactical employment of weapons. Other factors, such as the reduced volume of enemy supporting fires, also provide an advantage.

Analysis of the losses to antiarmor weapon systems on both sides showed some trends, but the data was inconclusive. Fifteen (15) more enemy antiarmor systems were lost (128 vs 143) while four (4) less friendly systems were killed (66 vs 62). The loss/survival data for tanks was the most dramatic. Dragons, LAWs and obstacles accounted for the increase in enemy losses (+49) while losses caused by the M-60 A1 tank and those due to other reasons decreased (-34). Friendly system losses to the BRDM and BTR-60 increased (+9), while those caused by BMPs, RPG-7s and the T-62 tank decreased (-13). The trend shows shorter range friendly antiarmor systems performing better with obstacles (8/13) at the expense of longer range systems (60/34). The same was true for enemy systems. Shorter range weapons except the BMP and RPG-7 did better (34/40) compared with the T-62 (28/28). Enhancement, therefore, cannot be confirmed and possibly could be disproved by the results. However, unanswered questions about the manner in which the model treats a simultaneous obstacle encounter and direct fire engagement of the same group of enemy vehicles precludes the author from reaching this conclusion.

RECOMMENDATIONS

Continued study of this subject is essential to the Army, especially as the cost of weapon systems increases. An accurate and unchallengable study, however, requires some changes to existing models and procedures. Any obstacle sub-module must be able to accept the number of obstacles by type that best supports a given commander's concept of operations. An artificial storage or memory constraint is unacceptable. A better system to differentiate between the effectiveness of obstacles is also necessary.

Large bridge or crater obstacles, in areas where bypass is difficult, delay enemy forces longer than similar obstacles in open terrain. More dense minefields attrit more enemy systems, delay forces for longer periods of time and are more difficult to breach/clear than less dense fields. These critical characteristics must be gamed. Each model used should also be closely examined in terms of interface ability. Simultaneous engagement of enemy forces by all available defending systems is essential. A direct fire engagement, for example, cannot be held up while the computer processes an obstacle engagement against the same group of enemy forces.

Most importantly, the subject of how non-weapon systems contribute to success in battle must be pursued. Without the ability to prove conclusively the value of an organization or capability to battlefield success, the entire structure of that organization is vulnerable to the axe of force planners as they search for more effective and efficient organizations in this era of reduced strength and increasing technical sophistication.

APPENDIX 1

(Classification)

Copy No. ___ of ___ Copies
52d Mech Div
Alsfeld (NB1922), FRG
140800 A Aug 19___
YZ51

OPORD 20

Reference: Map, Series M745, Deutschland, sheets L5120, 5122, 5124, 5126, 5128, 5320, 5322, 5324, 5326, 5328. Scale 1:50,000.

Time Zone Used Throughout the Order: Alpha

Task Organization:

Phase I

TF IKE (Covering Force Units)

TF 1-77 Mech (-)
- A/1-3 Armor
- 2-633 FA (155,SP) (DS)
- 2/A/1-441 ADA (VUL,SP) (DS)
- 1/D/52 Eng (DS)
- 1/A/52 Eng (OPCON)

TF 1-3 Armor (-)
- A/1-77 Mech
- 2-632 FA (155,SP) (DS)
- 1/A/1-441 ADA (VUL,SP) (DS)
- 2/D/52 Eng (DS)
- 1/B/52 Eng (OPCON)

TF 1-23 Cav
- 2-631 FA (155,SP) (DS)
- 3/A/1-441 ADA (VUL,SP) (DS)
- 3/D/52 Eng (DS)
- 1/C/52 Eng (OPCON)

TF IKE CONTROL

C/52 CBT AVN BN (OPCON)
61st FA Bde
 2-618 (8,SP)
A/1-441 ADA (VUL,SP) (DS)
D/52 Eng (DS)
1/B/52d CEWI

(Classification)

1st Bde
- 1-81 Mech
- 1-82 Mech
- 1-25 Armor
- C/52d Eng (-) (DS)

2d Bde
- 2-120 Inf
- 1-78 Mech
- 1-2 Armor
- B/52d Eng (-) (DS)
  - B/500th Cbt Eng Bn (Corps) (OPCON)
- 1,2/B/52d Avn (OPCON) (On Order)
- 733d Trans Lt/Mdm Trk Co (Corps) (DS)
- 3/B/52d CEWI (GS)

3d Bde
- 1-79 Mech
- 1-4 Armor
- 1-5 Armor
- C/1-441 ADA (DS)
- C/500th Eng (OPCON)
- 2/B/52d CEWI (GS)

Div Arty
- 1-40 FA (155,SP)
- 1-41 FA (155,SP)
- 1-42 FA (155,SP)
- 1-43 FA (8,SP)

Div Trp
- 1-441 ADA (C/V) (-)
- 500th Eng Bn (-) (DS)
- 52d Cbt Avn (-)
- 2-461 ADA (DS)
- 52d CEWI (-)
- 52d Eng (-)
- 52d MP Co
- 52d NBC Def Co
- 52d Sig Bn

DISCOM
- 52d Fin Co
- 52d Maint
- 52d Med
- 52d S&T

Phase II

2d Bde
- 2-120 Inf
- 1-78 Mech
- 1-2 Armor
- 1-77 Mech
- 1-41 FA (DS)
- A/1-441 ADA (DS)
- B/52d Eng (DS)
  - B/500th Cbt Eng Bn (Corps) (OPCON)
- 1,2/B/52d Avn (OPCON) (On Order)
- 733d Trans Lt/Mdm Trk Co (Corps) (DS)
- 3/B/52d CEWI (GS)

1st Bde
- 1-61 Mech
- 1-82 Mech
- 1-25 Armor
- C/52d Eng (DS)

3d Bde
- 1-79 Mech
- 1-3 Armor
- 1-4 Armor
- 1-5 Armor
- 1-42 FA (DS)
- B/1-441 ADA (DS)
- D/52d Eng (DS)
  - A/500th Eng (OPCON)
- 2/B/52d CEWI (GS)

Div Arty
- 1-40 FA
- 1-43 FA
- 61st FA Bde
  - 2-631 FA
  - 2-632 FA
  - 2-633 FA
  - 2-618 FA
- 52d Tgt Acq Btry

Div Trp
- 1-23 Cav
- 1-441 ADA (C/V) (DS)
- 500th Eng Bn (-)
- 52d Cbt Avn
- 52d CEWI
- 52d Eng Bn (-)
- 52d MP Co
- 52d NBC Def Co
- 52d Sig Bn

DISCOM
- 52d Fin Co
- 52d Maint
- 52d Med
- 52d S&T

1. SITUATION.

a. Enemy Forces. Annex A (Intelligence).

b. Friendly Forces.

(1) 10th US Corps establishes covering force along inner German boundary (IGB) and defends in sector 142000A Aug 19__. 201st ACR covers movement of corps into defensive positions, then screens corps left flank. 23d Amd Div establishes CG along IGB, then defends in sector on the left flank. 54th Mech Div establishes CF along the IGB, then defends in sector on the right flank. 313th Sep Mech Bde is corps reserve.

(2) Elements of the 10th TAF support 52d Mech Div.

(3) 2-461 ADA (Imp Hawk) DS 52d Mech Div.

(4) 1-431 ADA (C/V) GS 52d Mech Div.

(5) 500th Cbt Eng Bn (Corps) DS 52d Mech Div.

c. Attachments and Detachments. Task Organization.

2. MISSION.

52d Mech Div establishes covering force along inner German boundary (IGB) from NB735385 to NB628119, and defends in sector from NB510370 to NB410108, not later than 142000 Aug 19__.

3. EXECUTION.

a. Concept of Operation.

(1) Maneuver. The defensive operation will be conducted in two phases with Phase I being a defensive battle fought in the CFA and Phase II the defense of the MBA. Div establishes covering force consisting of TF IKE with 1-23 Cav, 1-77 Mech, and 1-3 Armor. Div defends in MBA with 3d Bde on the left and 2d Bde on the right. 1st Bde is Div reserve. TF IKE

conducts covering force operations in the CFA from the IGB to PL YELLOW, upon completion of the covering force mission, 1-23 Cav will screen the Div left flank, while 1-77 Mech and 1-3 Armor will come under the control of 2d Bde, respectively. 1st Bde be prepared for early and violent commitment both within the MBS and across the FEBA.

(2) Fires.

(a) Priority of air and artillery:

1. Phase I. TF 1-3, TF 1-77, 1-23 Cav in order.

2. Phase II. 3d Bde, 2d Bde, 1st Bde in order.

(b) All available artillery will support the CF operation. Priority of artillery is to counterfire.

(c) Priority of air defense to forces in the CF area; then CP LOCs, supply facilities and bridges in the MBA in division rear area, 3d Bde, 2d Bde, and 1st Bde in order.

(d) Para 3h, Fire Support.

(3) Obstacles.

(a) Priority of obstacle effort:

1. Phase I. TF 1-3, TF 1-77, 1-23 Cav, 3d Bde, 2d Bde, 1st Bde, LOCs, division rear area in order.

2. Phase II. 3d Bde, 2d Bde, 1st Bde, division rear area in order.

(b) Annex C (Obstacle).

b. 1st Bde.

(1) Phase I. Para 3p, Coordinating Instructions.

(2) Phase II.

(a) Maintain maximum dispersion to lessen effect of possible chem/nuc attack.

(b) Priority of commitment to 3d Bde sector.

(c) Be prepared to release one mech company for rear area security.

c. 2d Bde.

(1) Phase I. Para 3p, Coordinating Instructions.

(Classification)

(2) Phase II.

(a) Defend in sector.

(b) Establish and man contact points along PL YELLOW immediately on initiation of hostilities.

(c) Assist rearward passage of covering force.

(d) Be prepared to receive 1-77 mech from covering force.

(e) Maintain a defense with elements of 54th Mech Div along Division southern boundary.

(f) Be prepared to assist offensive operations by 1st Bde in sector.

(g) Plan on employment of two 2KT and one 5KT weapons in your sector contingent on release of the corps package.

d. 3d Bde.

(1) Phase I. Para 3p, Coordinating Instructions.

(2) Phase II.

(a) Defend in sector.

(b) Establish and man contact points along PL YELLOW immediately upon initiation of hostilities.

(c) Assist rearward passage of covering force.

(d) Be prepared to assist offensive operations by 1st Bde in sector.

(e) Be prepared to receive 1-3 Armor from covering force.

(f) Maintain a defense with elements of 23rd Armor Div along Division northern boundary.

(g) Plan on employment of three 2KT and two 5KT weapons in your sector contingent on release of the corps package.

e. 1-23 Cav.

(1) Phase I.

(a) On order establish defensive positions in forward sector from NB735384 to NB670301.

(b) Conduct delaying operation in CFA forward of phase line YELLOW to attrite assaulting first-echelon elements east of 52nd Mech Div FEBA.

(c) Maintain coordinated defense with 23d Armd Div covering force along the division northern boundary.

(d) Conduct coordination for passage with 3d Bde at contact points 1 and 3.

(2) Phase II. Conduct passage on order.

(a) On completion of CF operations (Phase I) revert to Division control; occupy BP 7.

(b) Be prepared to screen Div North flank or integration into MBA on order.

f. TF 1-3.

(1) Phase I.

(a) On order establish defensive positions in forward sector from NB67030 to NB664218.

(b) Conduct delaying operation in CFA forward of Phase Line YELLOW attrite assaulting first-echelon elements east of 52d Mech Div FEBA.

(c) Conduct coordination for passage with 2d and 3d Bdes at contact points 5 and 7, effect passage on order.

(2) Phase II.

(a) On completion of CF operations (Phase I) revert to 3d Bde control, occupy BP 8.

(b) Be prepared for integration into MBA on order.

g. TF 1-77.

(1) Phase I.

(a) On order establish defensive positions in forward sector from NB664218 to NB626120.

(b) Conduct delaying operations in CFA forward of Phase Line YELLOW to attrite assaulting first-echelon elements east of 52nd Mech Div FEBA.

(c) Maintain coordinated defense with 54th Mech Div covering force along the division southern boundary.

(d) Conduct coordination passage with 2nd Bde at contact points 9 and 11. Conduct passage on order.

(2) Phase II.

(a) On completion of CF operations (Phase I) revert to 2nd Bde control; occupy BP 14.

(b) Be prepared for integration into MBA on order.

h. Fire Support.

(1) Field Artillery:

(a) General.

1. Priority of fires to TF IKE for CF mission, on order to 3d Bde for MBA battle.

2. Counterfire priorities: enemy mortars and FA affecting committed Bdes, then nuclear capable fire systems.

(b) Organization for combat.

1. Phase I.
1-40 FA GSR 61st FA Bde
1-41 FA GSR 61st FA Bde
1-42 FA GSR 61st FA Bde
1-43 FA GSR 61st FA Bde

61st FA Bde: attached to TK IKE
2-631 FA (155,SP): DS TF 1-23
2-632 FA (155,SP): DS TF 1-3
2-633 FA (155,SP): DS TF 1-77
2-618 FA (8,SP): GS
52d Tgt Acq Btry: GS

2. Phase II.
1-40 FA GSR 1-42 FA X DS 1st Bde
1-41 FA DS 2d Bde
1-42 FA DS 3d Bde
1-43 FA GS 52d Mech Div
2-631 FA GS 52d Mech Div
2-632 FA reinf 1-41 FA
2-633 FA reinf 1-42 FA
2-618 FA GS 52d Mech Div
61st FA Bde: altn div arty TOC
52d Tgr Acq Btry: GS

(c) Special Instructions.

1. SEAD missions, when directed, will supersede all other priorities.

2. DIVARTY units will not exceed 50 percent of CSR on reinforcing CF arty.

3. MBA arty units will maintain silent status in forward supplemental positions near FEBA until artillery units support covering force cross Phase Line yellow.

4. CSR: (DTG) 142400 Aug 19__ 162400 Aug 19__.

	HE	ICM(AP)	ICM(DP)	WP	ILLUM	SMK
155mm	90	25	40	20	10	10
8 in.	70	20	30			

(2) Close Air Support.

(a) General.

1. Seventy CAS sorties, 10 BAI sorties allocated to 52d Mech Div for planning purposes from 142000A Aug 19__ to 152000A Aug 19__.

2. Priority of employment of CAS sorties to TF IKE for CF battle, then 3d Bde for MBS battle, on order 2d Bde MBA battle.

(b) Allocation for planning purposes only.

1. TF IKE: 26 CAS sorties.

2. 1st Bde: On order when committed.

3. 2d Bde: 10 CAS sorties.

4. 3d Bde: 20 CAS sorties.

5. Div Control: 16 CAS sorties, 10 BAI sorties.

(c) Special instructions.

1. Two sorties per mission for planning purposes.

2. Air support radar teams available thru FSE.

3. Groups of less than 10 armored vehicles are not lucrative CAS targets.

4. Response time: strip alert - 30 min.
air alert - 5 min.

(4) Nuclear.

(a) General. 52d Mech Div provides nuclear fire support for the authorized corps package. All nuclear targets will be approved/released by Cdr 52d Mech upon release by NATO/CORPS.

(b) Prescribed Nuclear Load.

	155-mm		8-in	
	0.2 KT	1 KT	2 KT	8 KT
1-40 FA	15	5		
1-41 FA	15	5		
1-42 FA	15	5		
1-43 FA			15	5

(c) Constraints:

1. Preclude the following collateral damage with high assurance in population centers over 5,000 population.

(a) Five percent incidence of injuries requiring hospitalization to personnel.

(b) Five percent incidence of moderate damage to single-story masonary buildings.

2. Do not exceed negligible risk to unwarned, exposed personnel.

(d) Target Defeat Criteria. Achieve at least 30 percent immediate transient incapacitation; i.e., 3,000 rad, to personnel in enemy maneuver units in the first- and second-echelon regiments, and 50 percent immediate transient incapacitation to personnel in artillery units.

(e) Nuclear Strike Warnings. Div SOP.

(f) On release of the corps package, brigade commanders will select targets for the following weapons:

	155-mm how/.2 KT	8-in how/2 KT	Totals
3d Bde	2	1	3
2d Bde	3	2	5
	5	3	8

(5) Chemical.

(a) General. Chemical fires will be initiated only after OPFOR first use. Approval/release will be authorized by this Headquarters. Due to limited delivery assets available chemical fires will be controlled at brigade level and reserved for most lucrative targets.

(b) Prescribed chemical load.

	GB	VX	HD
1-40 FA	200	50	50
1-41 FA	200	50	50
1-42 FA	200	50	50
1-43 FA	50	30	
2-618 FA	50	30	
2-631 FA	200	50	50
2-632 FA	200	50	50
2-633 FA	200	50	50

(c) Constraints.

1. Preclude use of persistent agents on target areas which are likely to be traversed by friendly units.

2. Do not exceed negligible risk to personnel from downwind hazard.

(d) Target Defeat Criteria.

Surprise Dosage Attack

(1) Non-Persistent Agent (GB). TOT with adequate number of rounds fired in mission to obtain a 50 percent coverage of target area with a casualty producing dosage.

Total Dosage Attack

(2) Persistent Agent (VX or HD) with adequate number of rounds fired in mission to obtain an 80 percent coverage of target area with a casualty producing dosage.

(e) Chemical Strike Warnings. Div SOP.

(3) Fire Support Coordinating Instructions.

(a) Fire planning and control.

1. 10th Corps FSCL is the IGB, eff upon initiation of hostilities.

2. During Phase I, CFL established by Cdr, TF IKE.

3. During Phase II, CFL established by Cdr, 52d Div.

(b) Safety.

1. Emergency cancellation of fires in clear text. Fires will be resumed on failure to authenticate.

2. Thirty minute notification required by 10th Corps to change FSCL.

i. Air Defense.

(1) 1-441 ADA: DS, protect TF IKE maneuver elements.

(2) 1-431 ADA (CV): GS, protect 61st FA Bde.

(3) 2-461 ADA (ImpHawk): [illegible] protect in priority 52d Div support area 52d Div rear CP.

(4) Annex F (Air Defense) (Omitted).

j. 52d CEWI.

(1) Task organization.

(2) Annex A (Intelligence).

(3) Annex G (Electronic Warfare) (Omitted).

k. Engineer Support.

(1) General.

(a) Priority of Support to TF IKE, then 3d Bde, then Div reserve on order.

(b) Priority of missions are countermobility, survivability, mobility in that order.

(2) Organization for Combat.

(a) Task organization.

(b) Div Engrs: 52d Engr:

(c) 500th Engr Cbt Bn: Div Control.

(3) Special Instructions.

(a) Priority for AVLB support to TF IKE, then 3d Bde.

(b) Annex C Engineer (Obstacle Plan).

l. 52d NBC Def Co: Prepare to release one plt to TF IKE and one plt each to 3d Bde and 2d Bde.

m. Div Trp (-): Task organization.

n. DISCOM:

(1) Initial location vic ROMROD NB1718.

(2) Prepare to receive one Mech Co to assist in rear area security.

o. Attack Helicopter Support:

(1) Phase I.

(a) C/52 (Atk Hel) OPCON TF IKE.

(b) B/52 (CBT SPT): div res; priority of spt to CF.

(c) D/52 (Atk Hel): div res, priority of spt to CF.

(d) 52d Avn Bn (-) GS:

(2) Phase II.

(a) A/52: div res; priority of spt to 3d Bde, 2d Bde, 1st Bde in order.

(b) C/52d Avn Bn (-) GS.

p. <u>Coordinating Instructions</u>.

(1) Covering force units.

(a) Phase I.

<u>1</u>. Man contact points in sector on establishing CF.

<u>2</u>. Plan operations and fires across the international boundary, but do not execute without approval of this HQ.

<u>3</u>. Establish and maintain crossing sites over the HAUNE River. Authorizations for destruction delegated to CF commander.

<u>4</u>. Prepare bridges over the WERRA River for destruction. Destruction authorization delegated to CF commander.

<u>5</u>. Release all attached elements on completion of passage of units through FEBA to parent 52d Armd Div unit.

<u>6</u>. Release 1-23 cav to division control. Direct 1-23 move to reserve BP 7 on completion of CF mission.

<u>7</u>. Enemy targets east of the Inner German border (IGB) will not be engaged until authorization to fire has been granted by Cdr, 52d Mech Div; or unless enemy violates the border. Covering force units report engagement by hostile forces immediately to this HQ.

<u>8</u>. Be prepared to accept attachment of divisional/brigade forces.

<u>9</u>. Be prepared to release unengaged forces.

<u>10</u>. Units will maintain FM listening silence west of the IGB until hostilities commence or on order this HQ.

<u>11</u>. Report primary and alternate GSR locations to TF IKE S2 prior to 142000.

12. 201 ACR overlay of active minefields, obstacles, and barriers in sector to be issued.

13. 201 ACR forces will clear covering force area NLT 141800 August. Units will conduct area turn-over coordination.

14. All civilians have been evacuated from Div sector by 201 ACR.

15. Route priorities to 1-23 Cav, TF 1-3 Armor, TF 1-77 Mech, in that order.

16. Movement Schedule: Annex B, Operations Overlay.

UNIT	SP TIME	ROUTE	RP TIME
1-23 Cav	1600	Gold	1845
TF 1-3 Armor	1600	Black	1740
TF 1-77 Mech	1600	Blue	1800

(b) Phase II. All CF units revert to control of Phase II parent unit.

(2) Main battle area units.

(a) Phase I.

1. Prepare battlefield along FEBA in sector.

2. Establish liaison with division CF control headquarters NLT 142000.

3. Establish and maintain contact points forward of sector prior to outbreak of hostilities.

4. Assist passage of CF elements through passage lanes/points.

5. Close passage lanes/points in sector on passage of CF elements.

6. MBA brigades prepare bridges over the FULDA River for destruction. Destruction authority delegated to brigade commander after Phase I (when CF has completed passage of FEBA).

7. Position AVLB assets to assist passage of CF.

(b) Phase II.

1. Bdes submit plans for use of CAS, ADA, CEWI, EW NLT 24 hours after closing initial positions.

2. Expedite movement of CF units through and away from FEBA.

(3) All units.

(a) Obstacles not executed immediately will be guarded and executed by maneuver units.

(b) Initiate coordination with German Territorial Forces in sector immediately.

(c) Attachments and detachments effective at 140600 August.

(d) Priority of road movement to corps reserve on commitment.

(e) EEI:

1. When has threat at any command level committed his second echelon?

2. When and where will the second-echelon TKD of the 24 CAA be committed?

3. Will the threat employ chemical or nuclear weapons? If so, when and where?

(f) This plan effective on receipt.

4. SERVICE SUPPORT.

Admin/Log Plan 6

5. COMMAND AND SIGNAL.

a. Command.

(1) Phase I.

(a) Division main CP located NB237187.

(b) TF IKE (Division Tac CP) Assistant Division Commander--Maneuver ADC-M control CF operations, located at NB 464341.

(c) Alternate div CP is Div Arty CP.

(2) Phase II.

(a) Division Main CP located NB237187.

(b) Division Tac CP located NB405290.

(c) Alternate Div CP is 61st FA Bde HQ.

b. Signal. Annex K (Communications-Electronics).

Current CEWI/CESI in effect.

* * * * * * *

Annexes: A--Intelligence
B--Operation Overlay
C--Engineer (Obstacle Plan)
D--Service Support
E--Fire Support
F--Air Defense (Omitted)
G--Electronic Warfare (Omitted)
H--Service Support Overlay
I--Communications-Electronics (Omitted)

Acknowledge.

STRETCH
MG

OFFICIAL:
S/Waters
WATERS
G3

Distribution: A
61st FA Bde

APPENDIX 2

THREAT FORCE TACTICAL CONCEPTS AND DOCTRINE

SEQUENCE OF COMMANDER AND STAFF ACTIONS

1. Commander keeps abreast of the tactical situation.
2. Combat directive received from higher headquarters. Commander studies directive and plans for use of available time.
3. Warning instructions given concerning desired briefings, and time and place of the issue of the commander's preliminary tactical decision. Staff prepares briefings. Commander restates mission and makes estimate of the situation based on staff briefings.
4. Commander gives his preliminary tactical decision to his subordinate commanders and staff.
5. Commander and subordinate commanders conduct a verifying reconnaissance.
6. During reconnaissance, commander makes his final tactical decision; and issues oral instructions to his subordinate commanders and staff confirming or changing his preliminary tactical decision.
7. Staff prepares complete combat plans or orders based on the commander's final tactical decision.

CONTENTS OF THE PRELIMINARY TACTICAL DECISION

1. Information on the enemy.
2. Mission of the command.
3. Missions of higher, supporting and adjacent units.
4. Commander's concept of the operation, tactics, direction of the main and secondary efforts, immediate and subsequent objectives of the command, and control measures for offensive operations, assignment of echelons, reserves, areas of responsibility, security area and control measures for defensive operations.
5. Coordination measures required for main and secondary efforts.
6. Coordination measures required between subordinate, adjacent and supporting units.
7. Task organization of the command and attached units, to include special units and equipment.
8. Immediate and subsequent objectives for subordinate units in offensive operations.
9. Mission and tactics for each stage of the operation.
10. Detailed procedures for combat support and service support.

FRONTAGES

	OFFENSE		DEFENSE
	Main Attack	Supporting Attack	
Mtz rifle div (MRD)	10-16 Km	20-30 Km	20-30 Km
Mtz ~~rifle~~ regt (MRR)	5-8 Km	10-16 Km	10-15 Km
Mtz rifle bn (MRB)	1000-1500 m	1700-2300 m	5-7.5 Km
Tank div	12-15 Km	25-30 Km	20-30 Km
Tank regt	6-7.5 Km	12.5-15 Km	10-15 Km
Tank bn	1000-1500 m	1700-2300 m	5-7.5 Km

OBJECTIVES

1. Immediate: Oriented on the enemy's direct support artillery and brigade/division reserves. Seized by the division first echelon.
2. Subsequent: Approximately 30 km from LD in nonnuclear; 60 km deep in nuclear enviornment. It is the primary mission for a 24-hour period as assigned to the division by the army commander.

OFFENSIVE ECHELONMENT

	1st Echelon	2nd Echelon	Reserve
MRD	2 MRR (+)	1 MRR	Tk regt (-)
MRR[1]	2 MRB (+)	1 MRB	Tk bn (-)
MRB	3 MR Co	None	1 Plt (AT, engr)
Tk div	2 Tk regt (+)	1 Tk regt (+)	MRR (3 MRB)
Tk regt[2]	2 Tk bn (+)	1 Tk bn	1 MRB (-)
Tk bn	3 Tk cos	None	1 Plt (Tk, engr)

1. When a tk bn from the tk regt is attached to the MRR it may: (1) be assigned to the first echelon and provide direct fire support. (2) be assigned to the 2nd echelon, or (3) be assigned to the reserve.
2. With an attached MRB, the Tk regt may conduct pursuit operations without attachment of MRR.

DEFENSIVE ECHELONMENT

	1st Echelon	2nd Echelon	Reserve
MRD	2 MRR	1 MRR	Tk regt
MRR	2 MRB (+)	1 MRB (+)	Co-sized unit
MRB[1]	2 MR Co (+)	1 MR Co (+)	Platoon
Tk div	The tk div is ill suited for the defense due to its limited amount of mtz units. When forced to defend with a tk div, every effort will be made to quickly replace it with a MRD.		

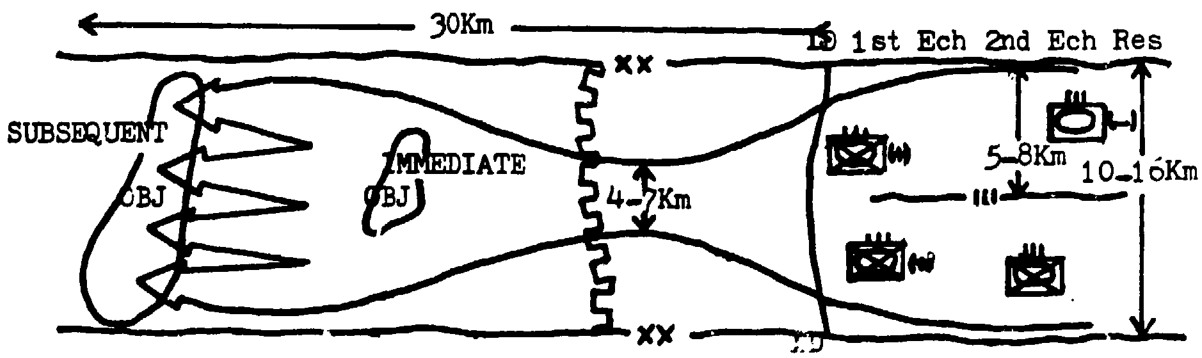
1. When in MRR 2nd echelon, MRB normally defends in 1st echelon.

MASS

To effect a breakthrough, the MRD or tank division will mass, within its assigned zone of action, on a 4 to 7 kilometer front. Being extremely vulnerable to conventional and nuclear fire while massed, the Soviet commander emphasizes speed for conduct of the breakthrough. Two to four hours are allotted from the time the division begins to mass until the breakthrough is completed and the forces again begin to disperse.

MRD DELIBERATE ATTACK

(ILLUSTRATION)



GENERAL

Offensive takes the general form of deep tank thrusts

Infantry and tank forces ore organized to break through the forward enemy defenses and push deep into the enemy rear.

Normally, two echelons are used; the 1st to make the breakthrough, encircle and destroy enemy forces; and create a gap for commitment of the 2nd echelon. The tank army is the exploitation force and passes through the gap.

Assembly areas depend on the terrain, type of operation, time and other related factors. Areas are usually large enough to permit 2 Km between battalion size units.

MISSIONS

FRONT: Capture objectives that may be more than 550 Km away and, if the situation permits, continue the advance an additional 500 Kms.

COMBINED ARMS ARMY: Destroy enemy resistance to the front and create gaps large enough to permit employment of large mobile forces of the Army Group. Continue operations against deep enemy reserves and destruction of encircled enemy forces..

DIVISION: Breakthrough forces, breakthrough defenses, destroy cohesive defense, divide into small isolated groups, destroy each in turn, and overrun division artillery. Expected to advance to a depth of 70-100 Km in the first 24-48 hours.

REGIMENT: Breakthrough enemy forward defenses, continue the attack against division reserves.

BATTALION: Breakthrough enemy forward defensive positions to permit establishment of a gap that can be exploited.

CONCENTRATION FOR THE OFFENSIVE

GENERAL: Units not in contact concentrate 60-75 Km behind the FEBA.

1ST ECHELON:

1st echelon divisions move to assembly areas 20-30 Km behind the FEBA.

Move by battalion and regemental columns, preceded by AT units, to attack positions or assembly areas 3-10 Km from the FEBA, during the night

Arrive in attack positions just prior to the firing of preparations.

Tank regiment moves from assembly area after the start of the preparation.

2ND ECHELON

Move from concentration areas to assembly areas vacated by 1st echelon.

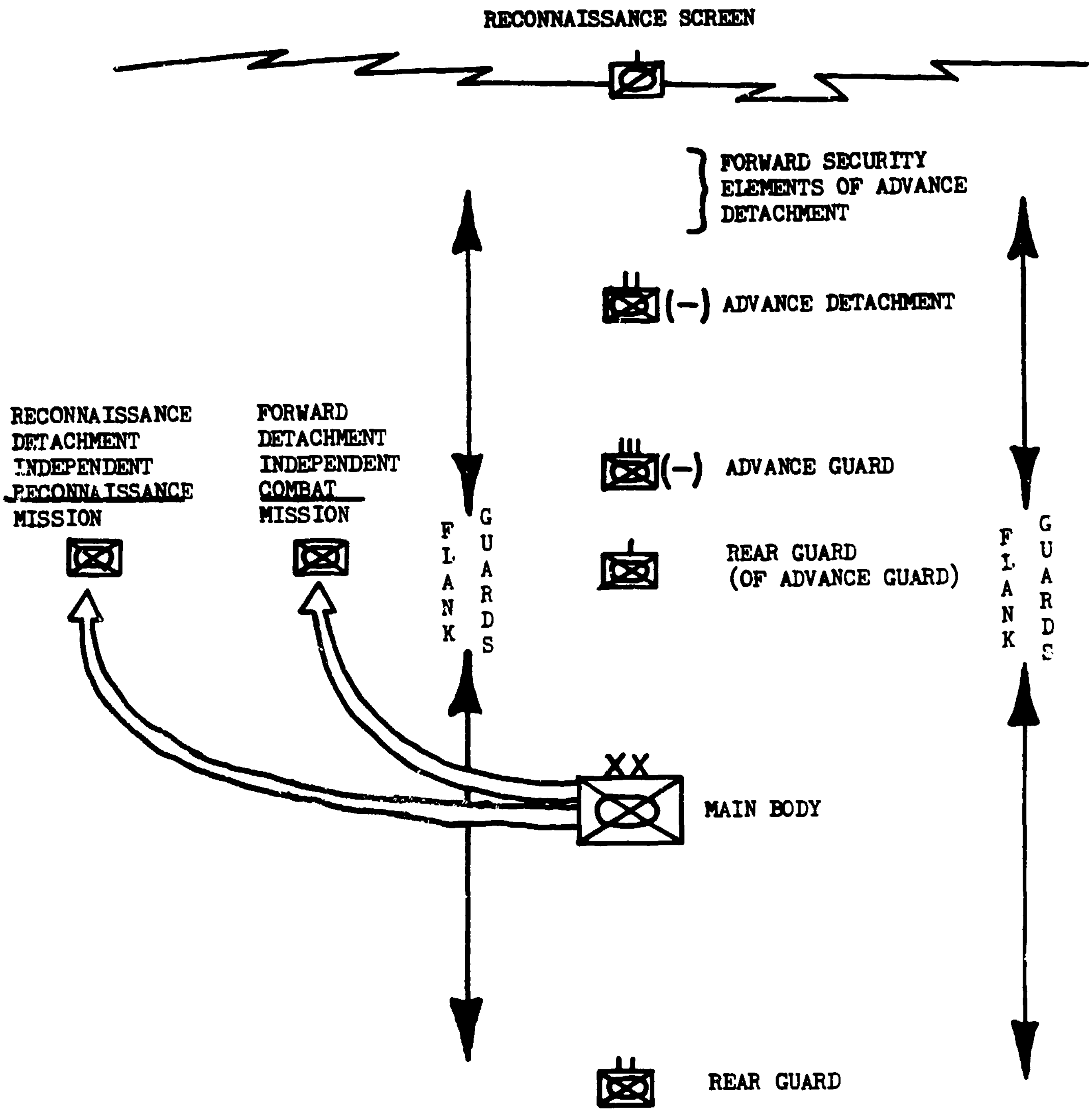
Tank and self propelled units move during preparations.

Artillery units will not move until the last possible hour, which will permit them to be in position 24 hour before the attack.

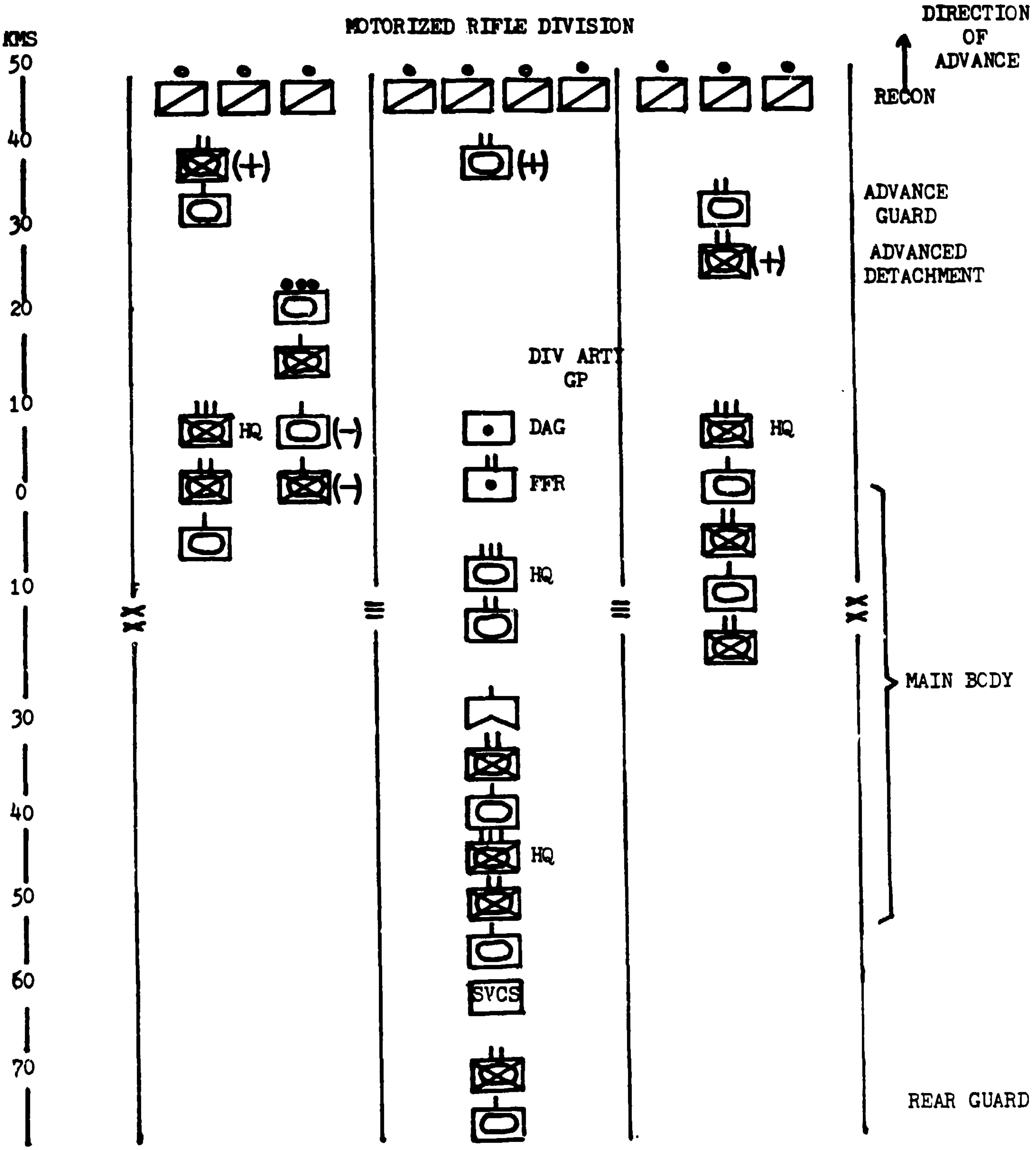
FRONT TYPICALLY DEPLOYED

	FRONTAGES		DEPTHS	ECHELONS		RESERVES	NOTES
	Main Attack	Secondary Atk		1st	2nd		
Front	SEE NOTES		About 180KM	Two CAA	One CAA One Tk A	30-180KM in rear of forces in contact. Front may constitute reserve by taking rifle regt or div from a subordinate army.	Typical Front zone of action is about 200KM wide and about 180KM deep, exclusive of area for service support units
CAA	About 30KM	Up to 80KM	About 100KM	Two MRD	One MRD One or two Tk D	MRR or seperate MR or Tk units made available by Front	
DIV	10-16KM	20-30KM	30-35KM	Two MRR	One reinf MRR	Med Tk regt considered div tk res or exploitation force. The Tk div res can be commited before, with, or after the 2nd ech to exploit gaps. If the tk regt is in 1st ech it will normally regain ctrl of detached bns when committed.	Med Tk regt used to reinforce 1st ech reg ,with one bn each and remainder of regt considered as div tk reserve.
REGT	5-8KM	10-15KM	15KM	Two reinf MR bns	One MR bn (follows 1st ech by 3-6KM & is usually cmtd fr march)	The tk bn is the cdrs tk res and is committed to exploit penetrations.	
BN	1-1.5KM	1.7-2.3KM	Up to 3KM	Two reinf MR Cos	One MR Co (May be reinf,fol about 800 m behind 1st ech.	Depending on width of sector, one MR Plt may be held as res. Tk res not usually held at battalion level.	

TYPICAL MARCH FORMATION OF
THE MOTORIZED RIFLE DIVISION



TACTICAL MARCH OF A MOTORIZED RIFLE DIVISION



NOTES:

1. The division is marching on four routes with three regiments up. The left motor rifle regiment has been allocated two routes.
2. Flank patrols and local security detachments are not shown.
3. Engineer route opening detachments (OODs) will accompany march security elements on each route.

TANK AND MOTORIZED RIFLE BATTALIONS

IN THE ADVANCED GUARD ROLE

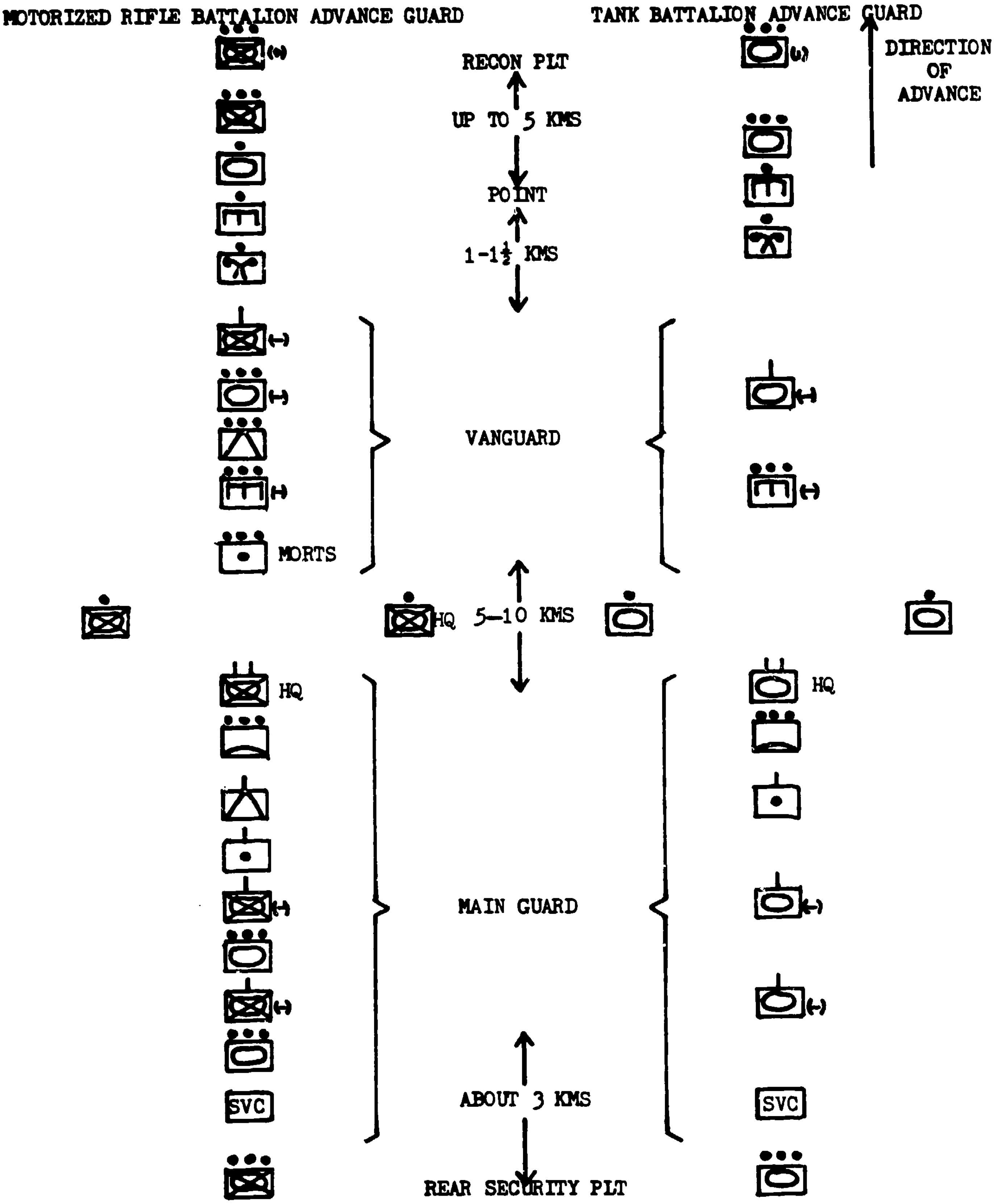
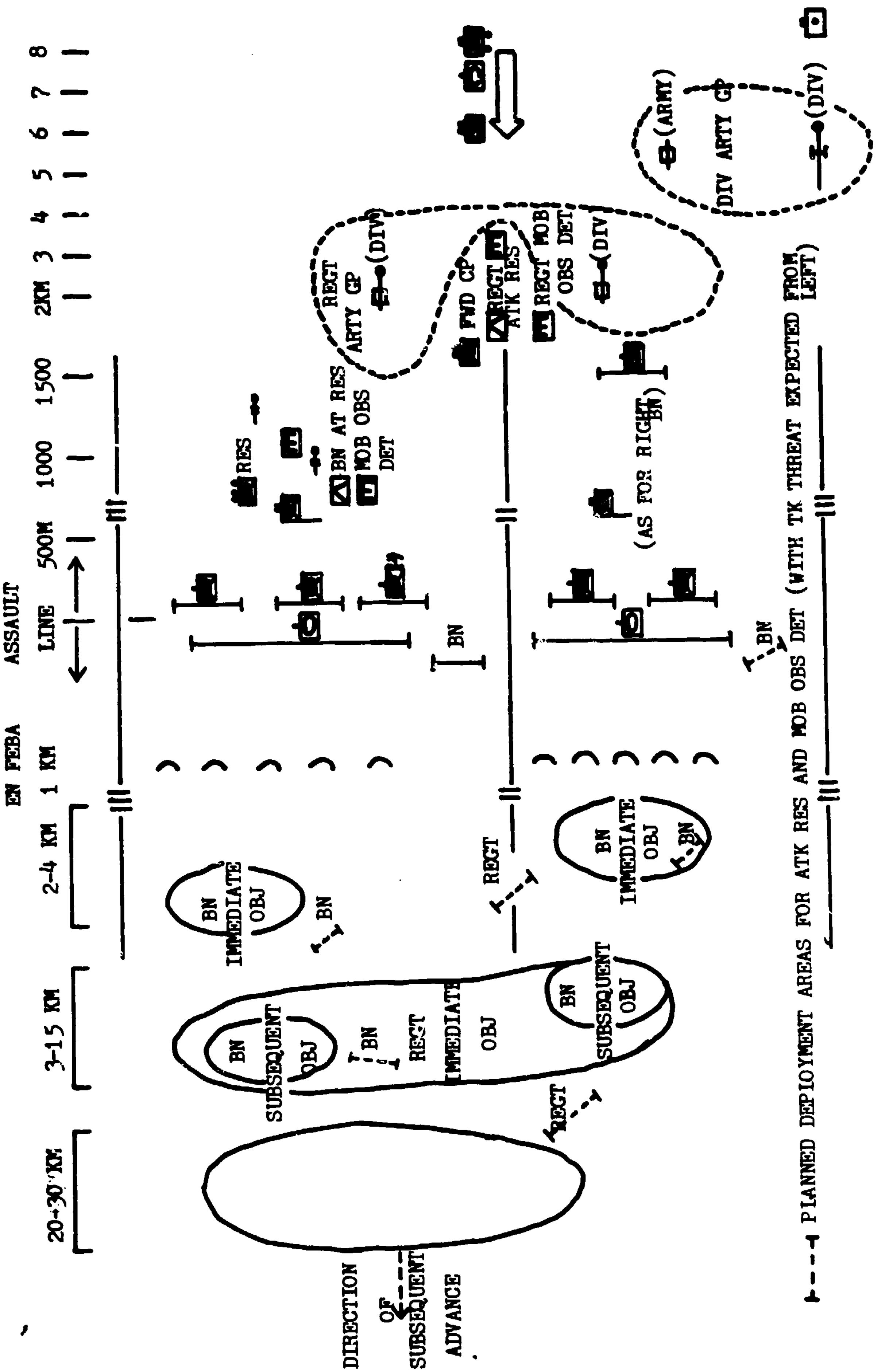


DIAGRAM: 2 BATTALION GROUPS IN THE ADVANCED GUARD ROLE

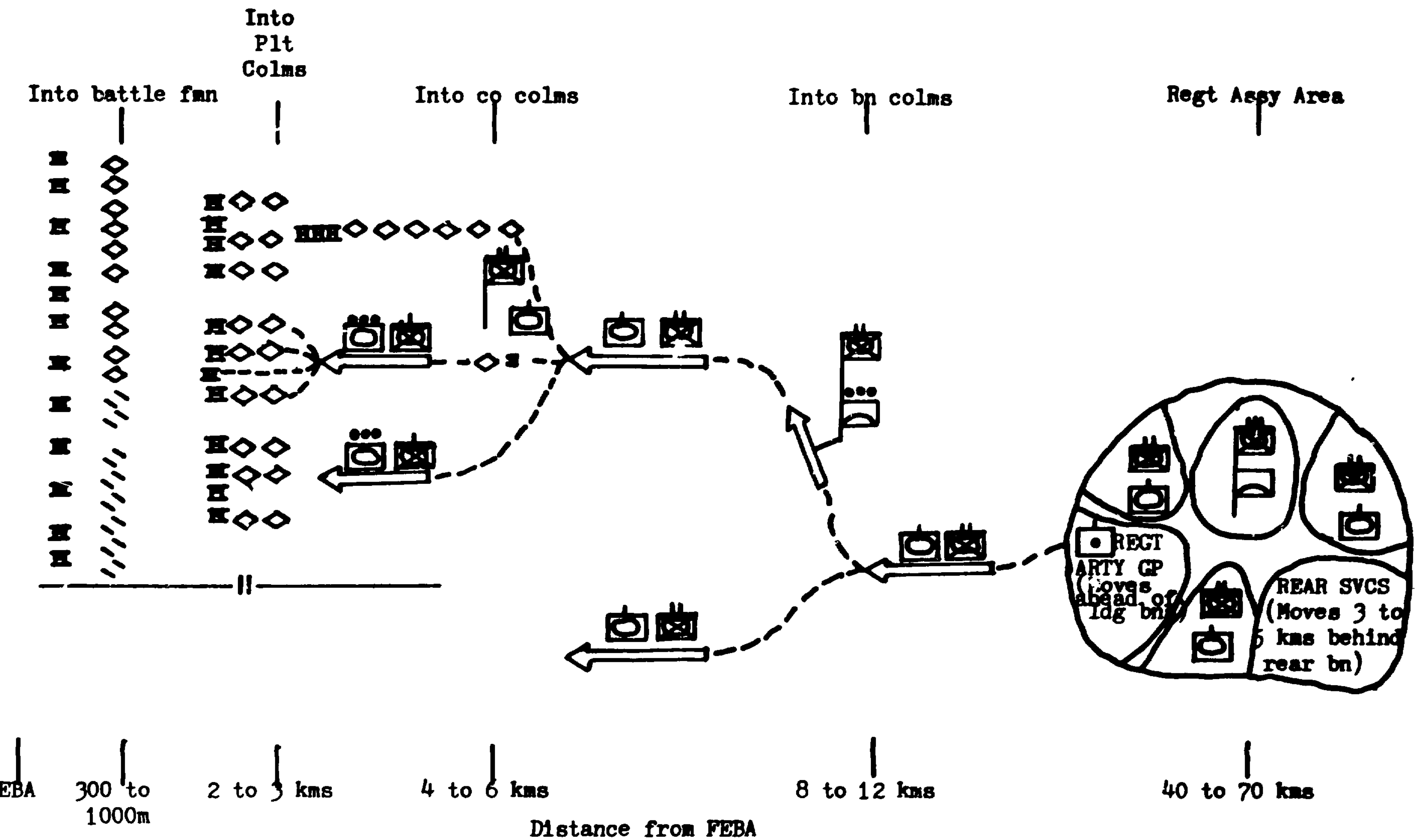
NOTE: Artillery under regimental control and the regimental anti-tank reserve (Motorized rifle regiment only) may also move within the zone shown, although these have not been included in the schematic.

MOTORIZED REGIMENT IN THE ATTACK



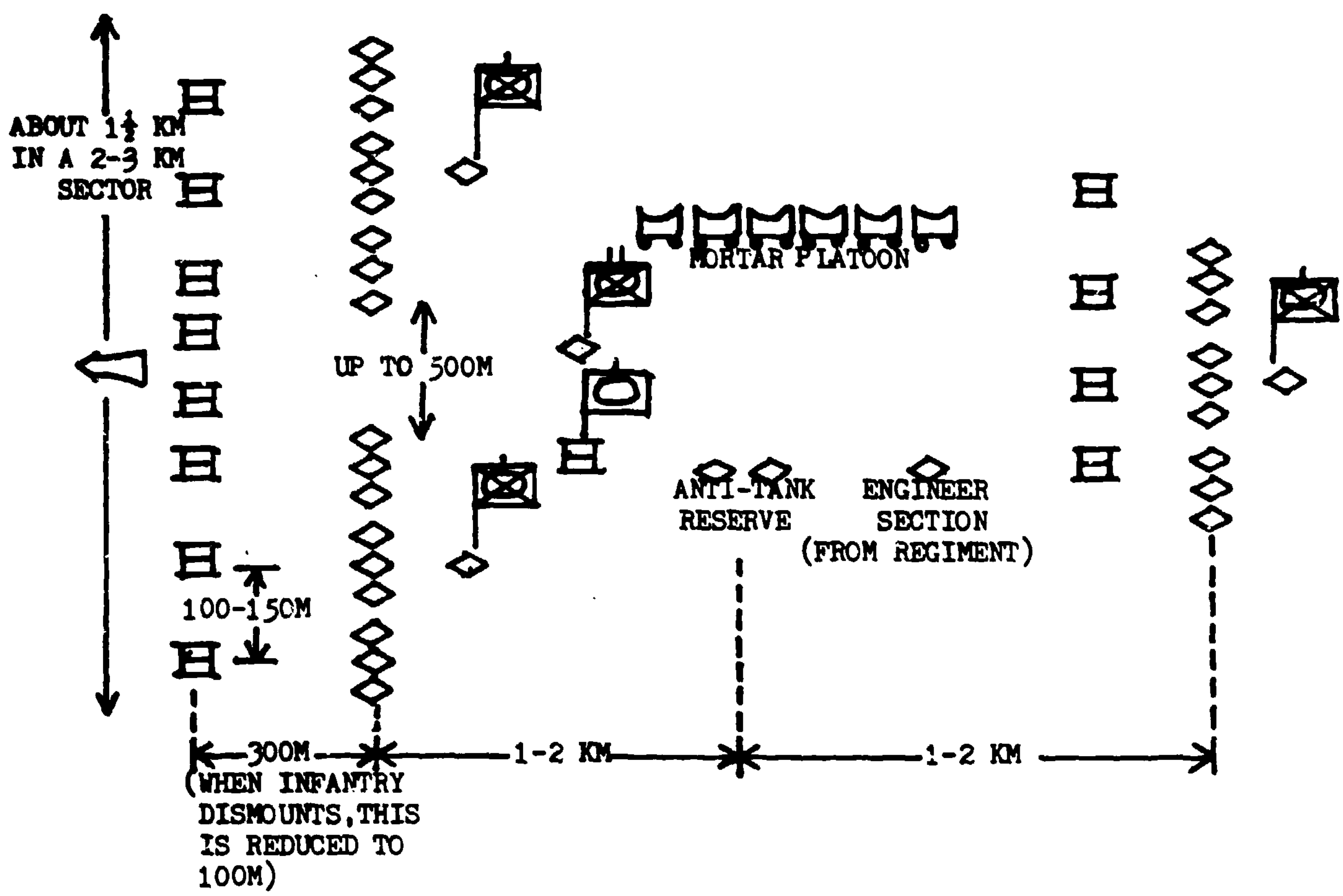
MOTORIZED RIFLE REGT

ATTACK FROM LINE OF MARCH



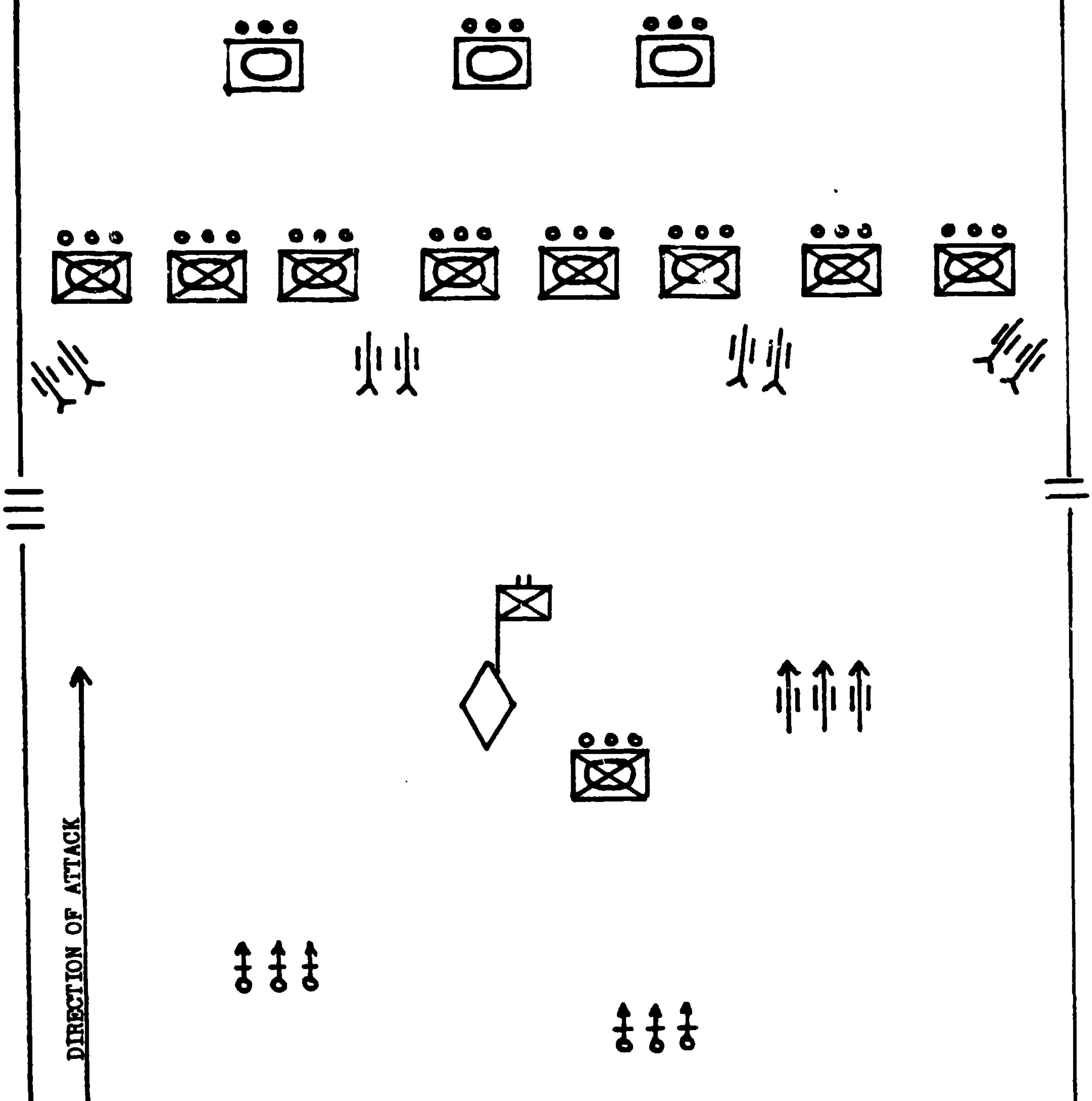
NOTE: For diagrammatic purposes the battalion has been shown with all three companies in the first echelon; normally at least one platoon will be maintained in battalion reserve.

MOTORIZED RIFLE BN IN THE ATTACK



NOTES: 1. Distances are approximate and not to scale
2. BMPS/APCS are 50-100m apart.

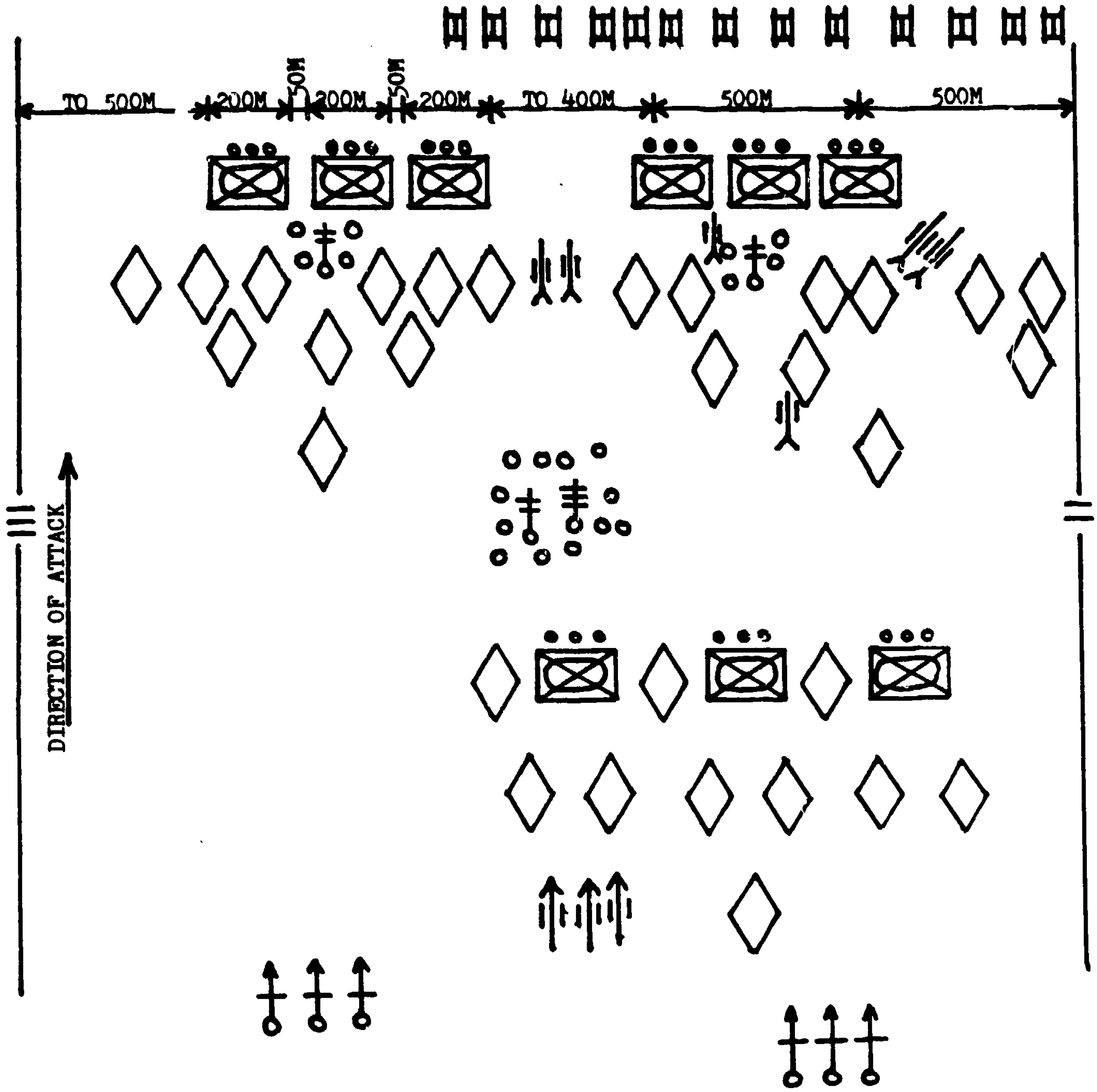
REINFORCED MOTORIZED RIFLE BATTALION IN A MOUNTED ASSAULT



NOTE: Motorized rifle battalion reinforced by a tank company, 73mm antitank gun battery, and a 120mm mortar battery.

REINFORCED MOTORIZED RIFLE

BATTALION IN A DISMOUNTED ATTACK



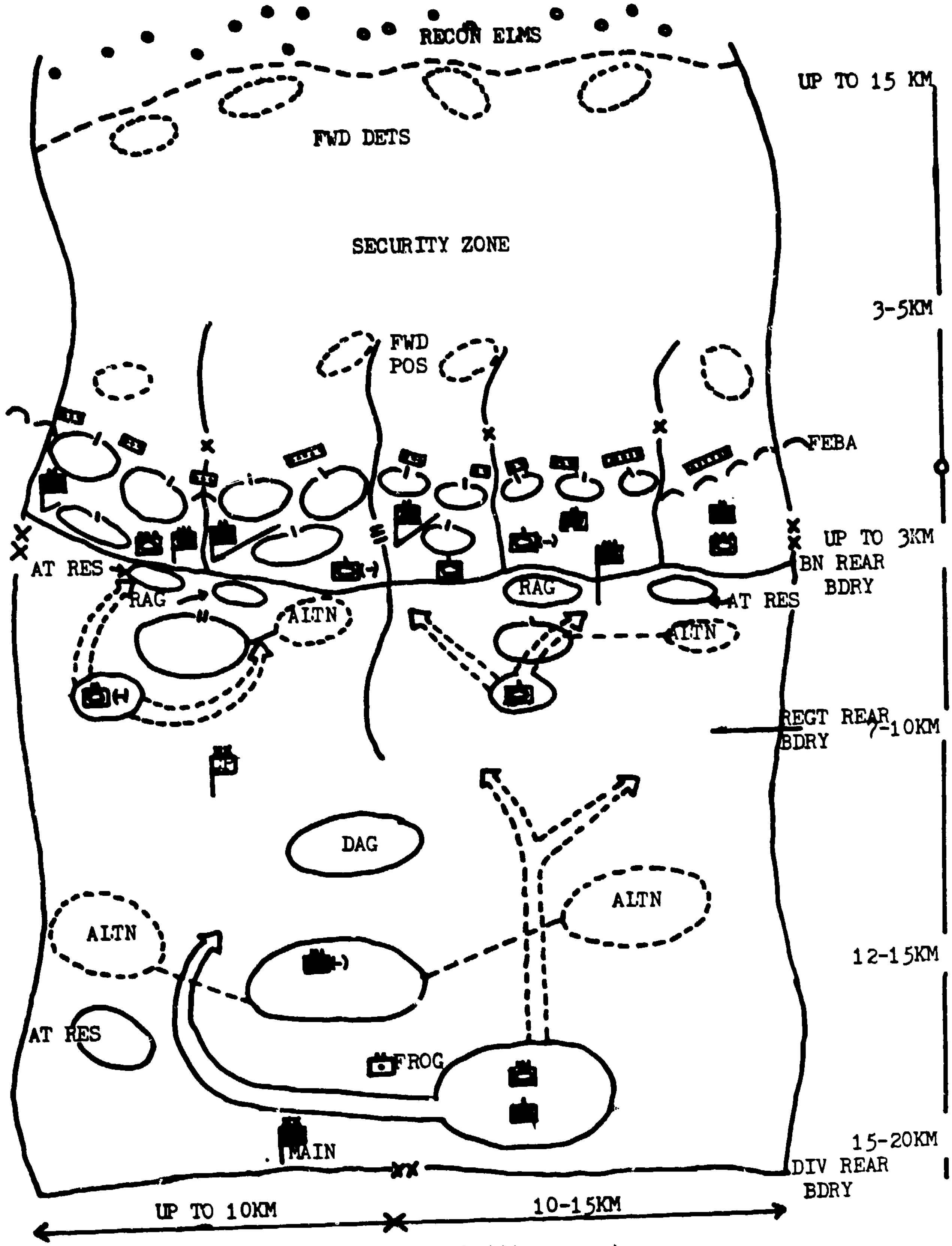
NOTE: Motorized rifle battalion reinforced by a tank company, 73mm antitank gun battery and a 120mm mortar battery

TYPICAL DEFENSIVE ORGANIZATION, SECURITY ZONE AND MAIN DEFENSE BELTS

UNIT	FRONTAGE/DEPTH	SECURITY ZONE	MAIN DEFENSE BELT 1st Echelon	MAIN DEFENSE BELT 2d Echelon	RESERVE
FRONT	Up to 400 KM wide & 400 KM deep	Estab & manned by each CAA in Front 1st Echelon. Usually 20-30 KM deep, but may be up to twice as deep if space & troops are available.	2 or 3 CAA	SEE NOTE (1) BELOW	SEE NOTE (1) BELOW
COMBINED ARMS ARMY (CAA)	About 100KM wide & about 100-120KM deep. If width is more than 90 KM, 1st ech is usually greater than 2 MRD.	Delaying psn estab. and manned by CAA 2d ech tank div & mech units. Bn covers about 8-12KM along delaying positions.	2-4 MRD	SEE NOTE (2) BELOW	General Res may consist of MRR from one of 1st ech MRD as well as Engr , AT & Arty res. SEE NOTE (2) BELOW.
MTR RIFLE DIV (MRD)	Width up to 45 KM	When not in contact, estab GOP as much as 25KM in front of the Main Def Belt. 2d ech MRR used for task.	2 MRR (ea rgt) def up to 10KM of Div zone. Def is organized on basis of Bn Def areas.	1 MRR which occupies psn across from rear of div zone about 4-8 KM deep & 10KM from FLT of Main Def Belt; not in assy area across rear of div zone.	Med Tk Regt under Div control as Div tk res. Elements of regt (2-3 co) may reinf mech regt Tk regt is usually located between 1st & 2d ech regt.
MTR RIFLE REGT	Width 10-15KM	Estab GOP 3-5KM in front of fwd bns from regimental 2d ech unit. Generally, a MRR disposed along ea 15KM of COPL.	2 Reinf MR Bns which def fwd 4 KM of regt zone. Usually reinf w/ med tk co, mort plt, AT gun plt & ATGM plt.	1 Reinf MR Bn loc in rear of regt zone about 3-5KM deep & 5-7KM from FLT of Main Def Occupies Bn Def area up to 5KM.	MR Co and AT plt from 2d ech of MR Bn may be held as regt res.
MTR RIFLE	Width 5-7KM	Loc sec 600-900 meters	2 MR Co along Bn zone FLT.	1 MR Co estab 3d def line 900m to rear of 2d def ln	Reinf AT Platoons

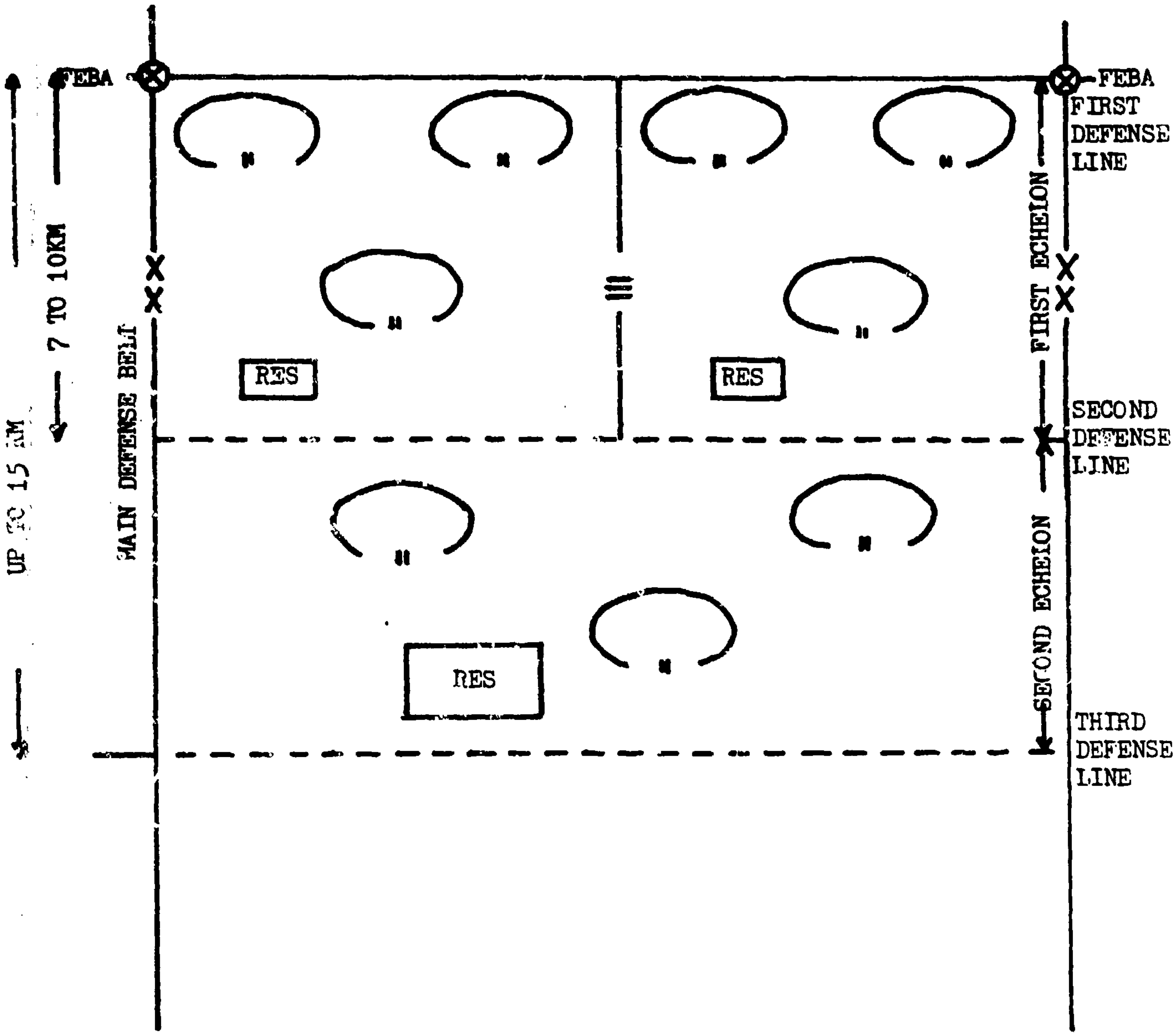
MOTORIZED RIFLE DIVISION

IN THE DEFENSE

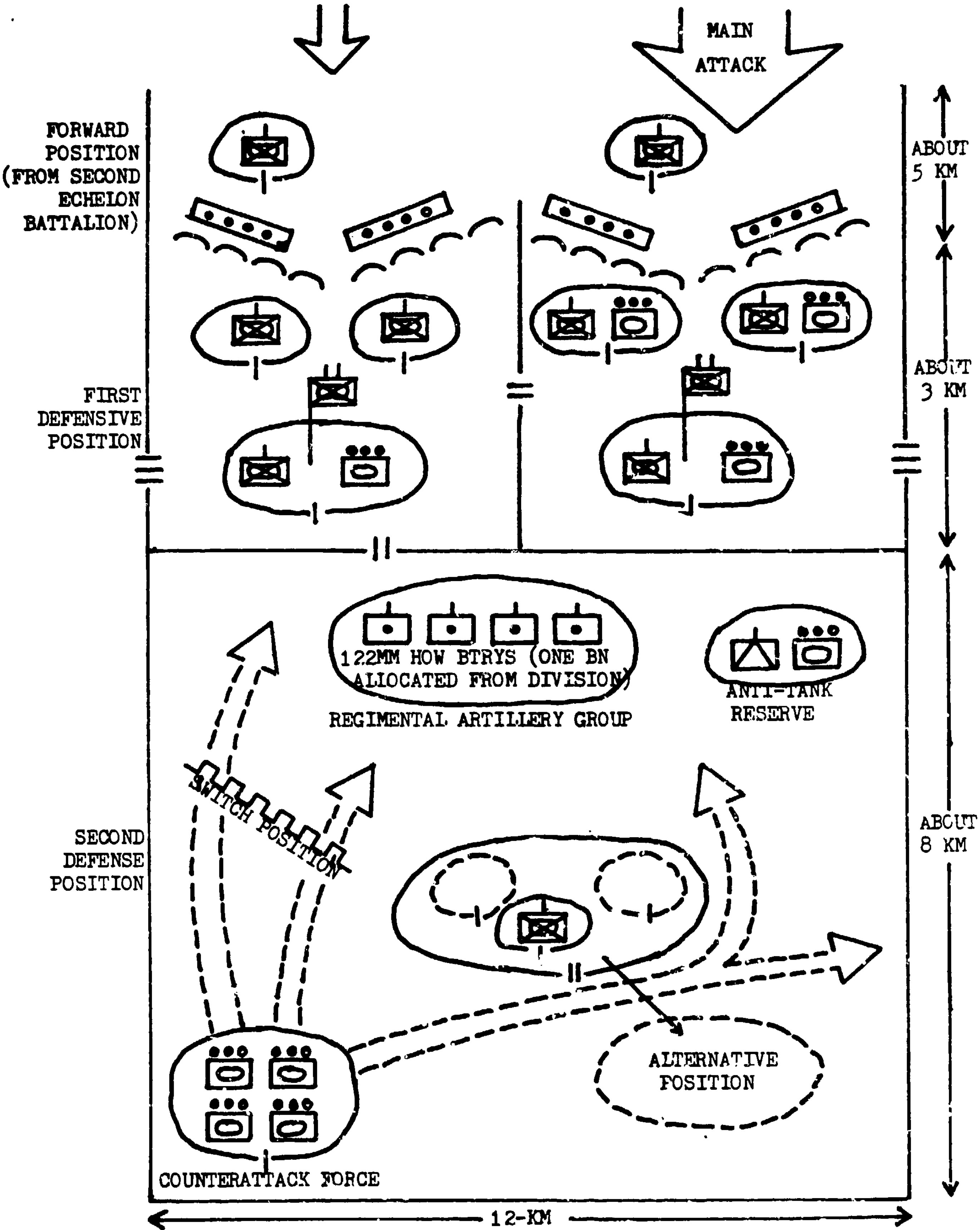


NOTES: 1. Right sector is subsidiary sector.
2. RAG-Regimental Artillery Group: DAG-Division Aritillery Gp.
3. Planned deployment areas for AT res not shown.

TYPICAL DEFENSIVE ORGANIZATION OF THE REGIMENTS OF A FIRST-ECHELON MOTORIZED RIFLE DIVISION



FIRST ECHELON MOTORIZED RIFLE BATTALION(+) IN THE DEFENSE



NOTE: Up to four planned deployment areas for the AT reserve not shown

EQUIPMENT CHARACTERISTICS

TABLE 1: ROCKETS AND ARTILLERY

CALIBER	MODEL	MAXIMUM RANGE (METERS)	MAXIMUM RATE OF FIRE (RPM)
152-mm How[1]	D-1	12,400	3-4
122-mm How[1]	D-30	15,300	7-8
152-mm G-H[1]	D-20	18,500	5-6
130-mm Gun	M-46	27,000	5-6
180-mm Gun	S-23	30,000	1
122-mm MRL	BM-21	20,500	40
FROG-7[2]	(549-mm)	70,000	4/Bn
120-mm Mortar	M-43	5,700	6-7
240-mm Mortar	M-53	10,000	1

NOTES: 1. Two self-propelled weapons, probably of 122-mm and 152-mm caliber, have entered the inventory of selected ground forces.
2. HE, nuclear, or chemical warheads.

TABLE 2: TANKS

MODEL	WEIGHT (TONS)	HEIGHT (FEET)	CREW	MAIN GUN	BASIC LOAD	SECONDARY
T-55	40	7.7	4	100-mm	43	7.62-mm mg (coax)
T-62	40	7.9	4	115-mm* (smoothbore)	40	12.7-mm AA mg
PT-76	14	7.1	3	76-mm	40	7.62-mm mg (coax)
ASU-85	14	6.8	4	85-mm	40	7.62-mm mg

NOTE: *Maximum effective range of 115-mm is approximately 2,000 meters.

TABLE 3: APCs AND RECONNAISSANCE VEHICLES

MODEL	MOBILITY	CREW	PASSENGERS	MAIN GUN	SECONDARY	SUPPLEMENTAL
BMP	TRACK	3	8	73-mm (SMOOTH)	7.62-mm mg (coax)	AT-3 SAGGER
BTR-60	WHEEL	2	8	14.5mm mg	7.62-mm mg	
BTR-50 PK	TRACK	2	20	7.62-mm mg		
BRDM-2	WHEEL	2	4	14.5-mm mg	7.62-mm mg	

NOTE: *The 57 or 85-mm gun can be mounted on the BTR-50PK.

TABLE 4: ANTITANK WEAPONS

MODEL	VEHICLE	RANGE (METERS)	FIRE CONTROL	NUMBER LAUNCHERS
AT-2 SWATTER	BRDM	500-3,000+	RADIO-GUIDED	4
AT-3 SWAGGER	BRDM BMP MANPACK	500-3000	WIRE -GUIDED	6
100mm AT GUN (T-12)	TOWED	8,500	OPTICAL	18/BN
RPG-7V (SEE TABLE 5)				

TABLE 5: SMALL ARMS AND RECOILLESS WEAPONS

CALIBER	MODEL	EFFECTIVE RANGE (METERS)	PRACTICAL RATE OF FIRE
7.62mm	AKM	300	60
7.62mm lmg	RPK (BIPOD)	800	50-150
7.62mm mg	PK	1,000	250
40mm AT LAUNCHER	RPG-7V	300-500	4-6
73mm RCL GUN	SPG-9	1,000	-

TABLE 6: ANTIAIRCRAFT GUNS

CALIBER	MODEL	RANGE	RATE OF FIRE	FIRE CONTROL
23-mm	ZU-23	2,500	1,000	OPTICAL
23-mm	ZSU-23-4	3,000	1,000 PER GUN	RADAR/OPTICAL
57-mm	ZSU-57-2	4,000	120	OPTICAL
57-mm	S-60	6,000	120	RADAR/OPTICAL

TABLE 7: SURFACE -TO-AIR MISSILES

MISSILE	NAME	SLANT RANGE (KM)*	LEVEL OF PROTECTION
SA-2	GUIDELINE	45	HIGH ALTITUDE
SA-3	GOA	6-22	MEDIUM-LOW ALTITUDE
SA-4	GANEF	70	MEDIUM-HIGH ALTITUDE
SA-6	GAINFUL	60	LOW ALTITUDE
SA-7	GRAIL	3.5	LOW ALTITUDE
SA-8	GECKO	10-15	LOW ALTITUDE
SA-9	GASKIN	7	LOW ALTITUDE

NOTE: Exact ranges are classified

HELICOPTERS

DESIGNATION	RANGE (MILES)	CARGO CAPACITY (POUNDS)	TROOP LIFT	CRUSING SPEED (MPH)	NOTES
MI-4 HOUND*	288	5,200	16	110	Piston engine, MG in front under fuselage
MI-6 HOOK*	120	26,450	65	155	Two shaft turbines Stub wings. MG in nose
MI-8 HIP*	280	8,820	24	140	Two shaft turbines Extermal mts for rkt pods. Std tp carrier for asslt ops.
MI-10 HARKE*	110	31,850 (SLING LOAD) 17,600	28	127	Two shaft turbines Flying crane. Sling designated MI-10K

MI-12 HOMER*	230	66,000		132	Four shaft turbines Rotor on tips of wings. Worlds lgst helicopter.
MI-24 HIND-A*	260		8-12	122	Rocket pods & AT missile launchers. HIND-B has pods w/o SAGGER launcher

NOTE: *US-NATO designation.

BRIDGES

DESIGNATION	CARRYING CAPACITY (TONS)	LENGTH OF SPAN (M/FT)	ASSEMBLY TIME	NOTES
T-54 MTU	50	12.1/40.3	3-MIN	Tank launched. Br pushed fwd horizontally across gap.
(T-55) MTU-20	50	20.4/68	3-MIN	Tank launched. Fold up ramps both ends lowered before launch. Horizontal launch.
KMM	15	6.9/23	30-45-MIN	Multi-span treadway. Launch fm rear of ZIL-157 truck
TMM	60	10.2/34	20-40-MIN	Multi-span sissors treadway br launched fm rear of KrAZ-214 truck.
LPP LIGHT	12&40	3.9/13.1	1.5-3M/MIN	1 ponton carried / truck
TPP HEAVY	50&70	3.6-4.8/12-16	.9-1.2M/MIN	6-8 ft of span / truck
PMP HEAVY	60	6.6/22	6M/MIN	4 section folding ponton carried on ea truck.
NZhM-56 Floating RR Bridge	150			Used in rear areas. No western counterpart.

AIR DEFENSE ARTILLERY WEAPONS

WEAPON CHARACTERISTICS	14.5-mm[1] ZPU-4	23-mm[1] ZU-23	23-mm[2,3] ZSU-23-4	57-mm[1,2] ZSU-57-2	57-mm[1,3] S-60
CREW	5	5	4	6	7
BASIC LOAD (RD)	4,800	2,400	UNK	316	200
AMMUNITION	AP/API	HE/HEI AP/API	HE/HEI AP/API-T	HE/HEI AP/API	HE/APHE
RATE OF FIRE (RPM/TUBE)					
CYCLIC	600	300-1,000	1,000	105-120	105-120
PRACTICAL	150	200	200	70	70
MAXIMUM RANGE (M)					
HORIZONTAL	8,000	7,000	7,000	12,000	12,000
VERTICAL	5,000	5,100	5,100	8,800	8,800
EFFECTIVE AA	1,400	2,500	3,000	4,000	6,000
ELEVATION (DEG)	+90	+90	+80	+85	+85
DEPRESSION (DEG)	+8.5	-10	-7	-5	-4
TRAVERSE (DEG)	360	360	360	360	360
MUZZLE VELOCITY (M/SEC)	1,000	970	970	1,000	1,000
VEHICLE	TOWED	TOWED	MODIFIED PT-76	MODIFIED T-54	TOWED
SPEED (KM/HR)	N/A	N/A	44	48	N/A
CRUSING RANGE (KM)	N/A	N/A	260	400	N/A
ENGINE	N/A	N/A	240HP 6-IN LINE, DIESEL	520HP V-12 DIESEL	N/A
TRENCH	N/A	N/A	2,800	2,700	N/A
STEP (MM)	N/A	N/A	1,100	800	N/A
SLOPE (DEG)	N/A	N/A	30	30	N/A
TILT (DEG)	N/A	N/A	UNK	30	N/A
FORD (MM)	N/A	N/A	1,070	1,400	N/A

NOTES:
1. Optical fire control system only.
2. Self-propelled system.
3. Has radar-directed fire control system.

AIR DEFENSE MISSILES

	GUIDELINE SA-2	GANEF SA-4	GAINFUL SA-6	GRAIL SA-7
GUIDANCE PRINCIPLE	COMMAND	COMMAND	SEMIACTIVE HOMING	INFRARED
MISSILE LENGTH (MM)	10,700	9,000	6,200	1,250
MISSILE DIAMETER (MM)	500[1]	800	335	70
RANGE (KM)				
MAXIMUM	40-50	70	60	3.5
MINIMUM	UNK	UNK	4	UNK
ALTITUDE (M)				
MAXIMUM	18,000	24,400	18,000	2,000
MINIMUM	UNK	UNK	100	50
WARHEAD FUZE	HE PROXIMITY	HE PROXIMITY (EST)	HE PROXIMITY(EST)	HE IMPACT
SPEED (MACH)	UNK	UNK	2.8	UNK

NOTE: 1. Second stage diameter.

APPENDIX 3

CATTS OBSTACLE SUBMODULE

5.5.3 Obstacle Submodule

The CATTS obstacle Submodule determines per time-step, whether a given unit encounters an obstacle while moving in the area of operation. An obstacle obstruction causes the unit to move up near the edge of the obstacle and halt for a period of time. The delay time to be endured depends upon the distance to be traversed across the obstacle, and the number of personnel and the amount of engineering support available to help reduce or breach the obstacle. A path through the obstacle is established, and when the entire delay time has elapsed, the unit is jumped across the obstacle. This submodule computes and updates all delay times and also allocates available engineering support among those units stopped by obstacles.

Figure 5-86 shows the subroutine linkages for this submodule. Brief descriptions of the subroutines and their principal inputs and outputs are provided in Table 5-37.

5.5.3.1 Operation

The Unit Movement Submodule provides the prime inputs which activate the Obstacle Submodule. These inputs for a given unit consist of the unit's present location (IXY(IU,K)), and its proposed new location (IUA(I), IVA(I)). They establish respectively, the initial and terminal points of the line segment defining the unit's intended path of movement. Note that if a unit is to remain halted during the time-step, or if it is already stopped by an obstacle, no obstacle encounters can occur. Full processing

by the Obstacle Submodule for such units is by-passed.

5.5.3.1.1 Obstacle Search

Given the initial (IXY(IU,K)) and terminal (IUA(I),IVA(I)) points of a unit's intended path of movement, the Obstacle Submodule examines all obstacles defined in the model to determine whether any of them will stand in the way (by subroutine OBSTACLE). Since an obstacle is modeled as a series of connecting line segments (with endpoints IOBX(I,IOBS), IOBY (I,IOBS)), and obstacle encounter is defined to be an intersection between the line segment describing the unit's intended path of movement and at least one of the line segments comprising the obstacle. To qualify as a point of obstacle obstruction, the point must simultaneously be within the closed segments of the movement path and the obstacle segment. To determine this, the equation specifying the infinite line passing through the unit's path of travel is constructed. Similarly, the equation describing the infinite line passing through a given line segment of the obstacle is established. The solution obtained when solving the above pair of equations simultaneously describes the point of intersection between the lines. Note that a solution (i.e., intersection point) is guaranteed unless the pair of equations describe parallel lines. Parallel lines will not yield a solution. An intersection point found to be within the endpoints of both the movement and the obstacle segments determines a legitimate obstacle obstruction. All segments comprising each and every obstacle defined in the model is checked in the manner described above (by OBSTACLE).

Processing by the Obstacle Submodule continues, depending upon whether obstructions have been found. When no obstructions occur (IOBNMBR=0) further processing is by-passed, and the unit is allowed to move to its proposed new location. On the other hand, should one or several obstruc-

tions exist, the submodule determines which obstruction is nearest relative to the unit's present location (Subroutine NEAROBS). This establishes the entry point into the first obstacle encountered by the unit as it attempts to move during the time-step. Any delay time suffered by the unit will be with respect to this obstacle. The unit is made to stop at a point just outside the obstacle near the point of entry (in OBSDELAY with local subroutine LOCATION).

5.5.3.1.2 <u>Moving the Unit to the Edge of the Obstacle</u>.

An obstacle encounter prevents a unit from moving to a desired location and instead repositions the unit in front of the obstacle. The submodule (subroutine OBSDELAY) attempts to relocate the unit as close as possible to the obstacle without placing the unit within, on, or beyond the obstacle. To achieve this, a small margin of distance (approximately 50 meters) away from the edge of the obstacle is maintained (local subroutine LOCATION, in OBSDELAY).

The repositioning is accompanied by a change in the unit's movement data and operational state (in OBSDELAY). This change reflects the fact that the unit is being halted. However, before the change is implemented, the units current state and movement data is saved (subroutine SAVEOLD). This information is restored after the unit has endured its delay and traveled across the obstacle; thus, the unit will be able to continue its original mission. The following hard coded changes are done to delay the unit:

(1) change its movement code (MVTCD(IU)) to seven (halted)

(2) change its operational state (IOPSTU(IU)) to 53 dismounted halted

Furthermore, the appropriate amount of delay time (OBSDEL(JU)) must be computed and the exact path of movement across the obstacle must be established (IBEYOND(JU)).

5.5.3.1.3 <u>Determining Exit Point Out of Obstacle</u>

The method of determining the exit point differs, depending on whether the obstructing obstacle is an area of linear obstacle. Knowledge of the exit point is required to establish the path to be taken through the obstacle. This knowledge allows the total distance along the path to be computed, which in turn is used to compute the period of delay to be suffered by the unit.

The exit point is determined (in OBSWIDTH) by extending the line segment describing the path of travel beyond the entry point until the line intersects another segment of the area obstacle. Area obstacles are modeled either as convex polygons, or as the union of rectangles; so the existence of an exit point is guaranteed. The calculations involved in determining an exit point is given by equation 3 of Section 5.5.3.3.

One type of area obstacle, minefields, demands special attention. The line extension of the path of travel may not provide the shortest breach path across the minefield. Special logic (subroutine BRCHPATH) exists in the submodule to recompute the exit point to achieve the shortest breach path across the minefield. Since all minefields are modeled as rectangles, the shortest path across is usually the path normal to the side of the rectangle containing the point of obstruction (i.e., the entry point). Thus the exit point corresponding to the normal path is computed. The equations used to make such a determination is given by equation 2 of Section 5.5.3.3. The submodule determines whether this new exit point is

adopted; otherwise, the original exit point produced by line extension is retained (in OBSWIDTH).

The determination of an exit point out of a linear obstacle is less complicated. A linear obstacle is modeled as a series of connecting line segments. Geometrically, line segments have no widths; thus, the point of obstruction with a linear obstacle is treated as an entry point as well as an exit point. For modeling convenience, however, a width of 10 meters is assumed when delay times must be computed for linear obstacles.

5.5.3.1.4 <u>Computation of Delay Time</u> (Subroutine ENGRSPT)

An obstacle encounter of any kind causes the unit to be delayed a minimum of three minutes. Additional delay time is added, depending on several factors:

(1) the type of obstacle encountered (IOBSTYPE(IOBS))

(2) distance to be traversed across the obstacle (OBSDIST)

(3) the number of personnel within the unit available to help reduce or breach the obstacle (1/2PERS(IU) or MAXWRKF(I))

(4) the availability of engineering support (IENGR)

Obstacles can be reduced or breached at different rates according to the type of obstacle encountered. The rate is measured in terms of manhours per meter (TASK(I)). Table 5-38 presents a list of obstacle types along with their associated reduction rates. The distance to be traversed across an obstacle has a direct effect on the amount of additional delay time assessed against the unit; the larger the distance, the greater the amount of delay time. Recall that the submodule computes this distance from knowledge of the entry and exit points.

The number of personnel in the unit (PERS(IU)) effects the computation of additional delay time. Units having a large quantity of personnel will

have more assets available to help reduce or breach the obstacle. The model presently assumes that the unit will utilize half of its personnel to accomplish this. Thus, more personnel within the unit, means a smaller amount of additional delay time assessed. The availability of engineering support generally means a reduction in delay time. This effect is modeled by including a multiplicative factor (ENGRFCTR(I)) in the calculation of delay time. The factor is a fraction having values ranging from zero to one, inclusively (0.0 = reduces the delay time entirely, 1.0 = has no effect on delay time). The multiplicative factor is a function of the type of obstacle encountered. Presently, the engineering support factor for each of the ten types of obstacles represented in the model is assumed to be 0.5. These factors can be modified by model inputs as more accurate data becomes available.

The total obstacle delay time assessed against a unit (OBSDEL(JU)) is obtained by adding three minutes to an additional delay period. This delay period is a function of the four factors discussed above. Equation 3 in Section 5.5.3.3 illustrates how the four factors are combined to establish the additional delay period.

5.5.3.1.5 Path to be Taken Through Obstacle

Even before modifying the unit's movement data or computing the delay time, the submodule must construct the path to be taken eventually by the unit as it travels through the obstacle. Recall that for a given obstruction, the exit point from the obstacle is known (EXITX,EXITY). Also, the unit's current location (before it has been relocated in front of the obstacle) is known (IXY(IU,K)). The path that will be taken is established as follows. Construct the directed line segment such that the segment's initial point is the unit's current location and the segment's terminal

point is the exit point out of the obstacle. The point obtained by extending this line segment a distance of 100 meters beyond the exit point provides the destination (IBEYOND(JU)) which the unit must travel towards to cross the obstacle. The 100 meters (BEYOND) provides a margin beyond the obstacle to ensure that the unit will clear the obstacle entirely. This margin is user defined by input and can be modified readily. The destination point is referenced by the submodule to initiate movement again when the unit's delay time has elapsed (subroutine OBSUPDAT). Equation 6 in Section 5.5.3.3 describes how the destination point is obtained.

5.5.3.1.6 Updating Delay Times

Delay times assessed against units are decremented every time-step (by OBSUPDAT). The amount decremented is equal to the period of time established for a time-step (IDTIME). Delay times can also be reduced by the presence of engineering support. However, the availability of engineering resources is limited; an allocation scheme determines which units should receive support. The allocation scheme is discussed in subsequent paragraphs.

The updating function consists of four responsibilities (all in OBSUPDAT). The first involves decrementing the delay times of units stopped by obstacles. This is done every time-step. The second responsibility handles all movements across obstacles. When a unit's delay period has elapsed (i.e., decremented to zero), movement data directing the trip across the obstacle is referenced (IBEYOND(JU)). The unit's updated movement status will allow it to move across the obstacle. The third responsibility involves updating the number of engineering tasks currently in progress (IRTASKS, IBTASKS). This is necessary for re-allocation of engineering support. The re-allocation attempts to distribute resources such that units suffering

the greatest amount of delay will have their delay times reduced. The fourth responsibility deals with units supplied (by an engineering unit) with rafts (subroutine HAVERAFT). Units having rafts among its equipment types will not be stopped by water obstacles (lakes or waterways). The submodule will determine whether the unit has a raft and if so, will update the unit's movements status so that it can ignore water obstacles. This raft capability was developed during Government testing, and has only been used for testing purposes.

Update processing is done only for units halted by obstacles, or moving through an obstacle. Units which are halted have their delay times decremented. If after decrementation, the delay time remains greater than zero, no further processing is conducted (the unit will remain halted). On the other hand, if the delay time has decremented to zero, the movement data necessary to guide the unit through the obstacle is set up (IOLDDATA (JU),JOLDDATA(JU),KOLDDATA(JU),LOLDDATA(JU)). This involves referencing the data describing the path to be taken through the obstacle. In particular, the unit is directed to move to a specific point (IBEYOND(JU)). The specific point is the endpoint of the path through the obstacle. In addition, the engineering task (if any) associated with this unit is released and made available for other halted units (IRTASKS,IBTASKS). Movement continues until the unit arrives at its designated point on the other side of the obstacle. Arrival will cause the unit's original movement status (prior to being stopped by the obstacle) to be restored. This restoration signifies the completion of the interaction between the unit and the obstacle. The unit has now breached the obstacle and is ready to resume its original mission.

5.5.3.1.7 Allocating Engineering Support (Subroutine ENGUPDAT)

Engineering support can provide a substantial reduction in delay time. The availability of engineering support (IENGR) is determined by the number of active engineering support units within each army (ITYPEU(IJT)=9). The presence of at least one active engineering unit within a given army is required for engineering support to be modeled.

Engineering support is represented by a reduction factor (ENGRFCTR(I)) which is applied to the delay time suffered by a unit when it has encountered an obstacle. The support given to the unit is called a task and the amount of reduction provided by the task depends on the type of obstacle stopping the unit. Presently, a maximum of ten engineering tasks can be conducted concurrently within a given army. This maximum can be modified by changing model inputs (MAXBTASK,MAXRTASK).

Available engineering support is distributed among those units (within given army) which are unable to move due to obstruction by an obstacle. Each request for support is granted automatically unless the limit (MAXBTASK or MAXRTASK) has been reached. Once the maximum number of engineering tasks being conducted simultaneously has been attained (for a given army), additional requests are denied, until the number of tasks has been reduced below the respective maximum. Requests are granted on the basis of longest delay time (i.e., the unit being stopped for the longest period of time (OBSDEL(JU)) will receive engineering support first). If several units have the same waiting time, requests are granted in numerical order according to unit number. The allocation scheme attempts to distribute all available engineering support every time-step.

5.5.3.1.8 Minefield Encounters

Minefields are a type of obstacle (IOBTYP=3) in the model which demand special attention. They are unlike the other types of obstacles modeled because of the following:

(1) minefields are the only area obstacles modeled which may comprise of more than one disjoint rectangular piece

(2) minefields are the only obstacles modeled which may inflict damage and casualty

Like all other obstacle types, minefields are modeled which may impede the progress of units and operational groupings.

Thus far, minefields are the only obstacle type modeled with the capability of simulating damage and casualty. When a unit is detained by a minefield, personnel casualties and/or damage to equipment must be accounted for (subroutine OBSDELAY). This attrition depends mainly upon whether the unit is mounted or dismounted (FTMVT(JU)). Dismounted units suffer one personnel casualty when it encounters a minefield. A mounted unit will have the first self-propelled vehicle in its equipment list destroyed; the unit also suffers the expected number of personnel casualties associated with the destruction of this vehicle (PCPEC(IEQ)). Personnel killed are assumed to come from the most vulnerable classes. Casualty and damage statistics are stored into memory (STATS(I,J,K)) for updating and alert generation purposes.

Breaching a minefield consists of a series of calculations that determine the shortest route through the minefield (subroutine BRCHPATH). Since minefields have a rectangle geometry, the shortest path across is usually the path normal to the side of the rectangle containing the point of obstruction. However, the normal path is not necessarily the shortest path. For instance, when a unit's path of travel is such that it cuts the

corner of the rectangle representing a minefield, the actual distance traversed across may be less than the normal distance. Thus, when breaching a minefield in the CATTS model, the path of least distance is established and taken after the unit has suffered delay and casualties.

5.5.3.2 Assumptions and Data Sources

The assumptions used in constructing the Obstacle Submodule are:

(1) The CATTS math model assumes that 11 different types of obstacles exist. The distinction between types lies mainly in the amount of delay time assessed against a unit when it encounters an obstacle. The ten types of obstacles (IOBSTYPE(IOB)) currently modeled are:

(a) crater field

(b) general mass obstacle

(c) minefield

(d) lake

(e) waterway (canal, river, etc.)

(f) concertina barrier

(g) fixed wall barrier

(h) ditch

(i) ravine

(j) cliff

(k) terrain

Obstacle types a through f are termed area obstacles. Obstacles submodule. Obstacles a through c and f, d, e and k are processed by the Cross Country Movement are mathematically represented either as:

(a) simple convex polygons, or

(b) the union of a set of rectangles generated from a given width and a series of connecting line segments which do not close to form a polygon nor intersect each other except at the connecting endpoints.

Obstacle types g through k are called linear obstacles because they are simply comprised of a series of connecting straight line segments.

Data Source: TRW Report 16905-6010-R0-00, "Small Independent Action Forces (SIAF) System Model User's Manual," Volume , 31 August 1971.

Engineering judgement by R. Cho at TRW.

(2) At the beginning of a simulation exercise, initial model inputs should never locate units inside an area obstacle, nor should an instructor interactively relocate units inside an area obstacle.

Data Source: Engineering judgement by R. Cho at TRW.

(3) When defining a route of any kind in the model (this includes special routes, and control measure routes), none of the route points comprising the route may be located inside an area obstacle. Thus, any segment making up a route may span across an area obstacle, but under no circumstances should the endpoints of a segment lie inside an area obstacle.

Data Source: Engineering judgement by R. Cho at TRW.

(4) The path of travel required to cross an area obstacle will always be given by a single straight line segment originating at the point of obstruction and terminating at a point 100 meters beyond the exit point out of the obstacle (IBEYOND(JU)). The endpoints of the path of travel are different if a nearby bridge is used to

cross the obstacle. In this case, the endpoints of the path of movement are made to coincide with the endpoints of the bridge.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(5) Since a linear obstacle is modeled as a series of connecting line segments, its entry point and the exit point coincide (at the point of obstruction). Geometrically, line segments have no width; but for modeling convenience, all linear obstacles are artificially assigned a width of 10 meters.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(6) When a unit encounters an obstacle, it is assumed that half of the total number of personnel within the unit is used as a work force to help reduce or breach the obstacle. The period of delay to be endured by the unit depends in part on the number of personnel available to help reduce the obstacle; the more people available to work, the shorter the delay time assessed against the unit.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(7) When a unit encounters an obstacle of any type, it is delayed a minimum of two minutes. However, additional delay is given depending on the following factors:

(a) the type of obstacle encountered (IOBSTYPE(IOBS))

(b) the distance to be traversed in order to cross over the obstacle (OBSDIST)

(c) the availability of engineering support (IENGR)

(d) the number of personnel remaining in the unit to help reduce the obstacle (1/2PERS(IU) or MAXWRKF(I))

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(8) Engineering support is assumed to exist in the model, if for a given army, at least one of its units is an engineering unit (ITYPEU(IUT)=9). If no engineering unit is active within a given army, then engineering support will not be available to that army.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(9) Engineering support is allocated such that units suffering the greatest amount of delay during the current time step will receive first priority. Should several units be eligible (i.e., several units have the same longest delay time), support is allocated in numerical order according to unit number.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

(10) The effect of engineering support is to reduce delay time when an obstacle is encountered. The reduction is represented by a fraction (ENGRFCTR(I)) having values which range from 0.0 (reduces the delay time entirely) to 1.0 (no reduction of delay time whatsoever). Each type of obstacle modeled has a unique engineering reduction factor. Presently, it is assumed that the ten different types of obstacles currently modeled, have the same reduction factor of 0.5. However, since these factors are defined by user inputs, they can be modified readily when more accurate data is available.

<u>Data Source</u>: Engineering judgement by R. Cho at TRW.

5.5.3.3. <u>Equations</u>

A discussion of the principal equations used in the obstacle submodule logic has been deleted from this appendix. The data may be examined in the original CATTS instruction booklet beginning on page 5-576.

APPENDIX 4

STANDARD OBSTACLE DATA

GENERAL: Standard obstacles have been developed to permit rapid material, transportation, installation time and installation effort estimates to be made early in any obstacle planning cycle. The obstacles depicted on this card have been developed based on typical terrain, threat capabilities, and materials available in the European Theater of Operations. Standard obstacles are designed on the building block principle. If the required obstacle is larger than the standard obstacle, use multiples of the standard. For example, if a 300 meter wide minefield is required, simply plan to install three 100m standard minefields, multiplying the bill of materials and installation time accordingly. For simplification, ease of planning and flexibility, standard obstacles should be used in the General Defense Plan whenever possible. Continued development and refinement of these obstacles is essential.

OBSTACLE DESIGNATORS:

A-ABATIS

AB-SINGLE LANE HIGHWAY BRIDGE

ABP-SINGLE LANE HIGHWAY BRIDGE PRE-CHAMBERED

AC-DELIBERATE ROAD CRATER

AF-AIRFIELD

AM-M-15 MINEFIELD (P_e=.5)

AMD-M-15 MINEFIELD (P_e=.75)

BB-DOUBLE LANE HIGHWAY BRIDGE

BBP-DOUBLE LANE HIGHWAY BRIDGE, PRE-CHAMBERED

BC-M-180 ROAD CRATER

FB-FOOTBRIDGE

BM-M-21 MINEFIELD (P_e=.5)

BMD-M-21 MINEFIELD (P_e=.75

CB-AUTOBAHN BRIDGE

CBP-AUTOBAHN BRIDGE, PRE-CHAMBERED

CC-ROAD CRATER, PRE-CHAMBERED

CM-(A-B-C-D) M-34 MINEFIELDS (P_e=.5)

D-DAM

DB-SINGLE TRACK RAILROAD BRIDGE

DBP-SINGLE TRACK RAILROAD BRIDGE, PRE-CHAMBERED

DM-(A-B-C-D) M-34 MINEFIELDS (P_e=.5)

EB-DOUBLE TRACK RAILROAD BRIDGE

EBP-DOUBLE TRACK RAILROAD BRIDGE, PRE-CHAMBERED

FY-FERRY

LO-LOG OBSTACLE

NL-NAVIGATION LOCK

P-POL FACILITY

PL-PIPELINE

PLT-POWERLINE TOWER

R-RUBBLE

RS-RADIO STATION

T-TUNNEL

TD-TANK DITCH

TP-TUNNEL, PRE-CHAMBERED

TV-TELEVISION STATION

WO-WIRE OBSTACLE

ABATIS

1. Designator: A
2. Authority To Install: Maneuver Commander, All Levels.
3. Dimensions: 12x30 meters (width x length)
4. Installation Effort: 2 Squad Hours
5. Bill of Materials:

Item	DODIC	WEIGHT	CUBE
20 ea. 6 1/4 lb C4 charges (5 ea 1 1/4 lb blocks/charge)	M023	151 lbs.	5.6 ft^3
640 meters Det Cord	M456	77 lbs.	2.6 ft^3
6 meters Time Fuse	M670		
4 ea Non-electice Caps	M131		
4 ea Fuse Lighters	M766	2 lbs.	.1 ft^3
6 ea M-15 AT Mines	K180	294 lbs.	7.1 ft^3
4 ea M-16 AP Mines	K092	45 lbs.	.8 ft^3
	TOTAL	569 lbs.	16.2 ft^3
		.28 tons	

NOTES: This obstacle is designed to destroy 20 ea. 10 inch diameter trees. Weight and cube calculations include packaging. Longer abatis can be installed by using more than one standard obstacle. The dual primed non-electric firing system will be set up as shown in figure 1 below (omitted). The trees will be notched with an axe prior to the placement of charges. Charges, secured with wire or rope, above ground level on the side of the tree in the direction of fall. Time fuse should be cut to allow one side of the obstacle to be detonated prior to the other. This eliminates the possibility of trees deflecting one another from their desired direction of fall. Once the abatis has been blown, the mines will be placed throughout the obstacle to hamper enemy breeching.

M-21 MINEFIELDS

1. Designator: BM
2. Authority to Install: Task Force (Battalion) Commander
3. Dimensions: 100x58 meters (width x depth)
4. Density: .004 Mines Per Square Meter
5. Probability of Encounter: .5
6. Installation Time: 3 ½ Squad Hours

7. Bill of Materials:

	DODIC	WEIGHT	CUBE
23 ea. M-21 AT Mines	K181	545 lbs.	24.9 ft^3
8 ea. M-16 AP Mines	K092	90 lbs.	1.6 ft^3
800 meters Barbed Wire		183 lbs.	1.9 ft^3
19 ea. Minefield Signs		8 lbs.	.3 ft^3
19 ea. Long Pickets		188 lbs.	2.6 ft^3
	TOTAL	1014 lbs.	31.3 ft^3
		.5 tons	

NOTES: This minefield is used for the same purpose and in the same manner as the AM minefield. (omitted) No antihandling devices will be employed. The utilization of the M-21 AT mine with the M607 tilt rod fuse requires that the mine be buried to stabilize the charge.
Reporting: Reports for the BM minefield are the same as for the AM minefield.
Installation Procedures: (omitted)

REINFORCED MINEFIELD

1. Designator: BMD
2. Authority To Install: Task Force (Battalion) Commander
3. Dimensions: 100x58 meters (width x depth)
4. Density: .008 Mines Per Square Meter
5. Probability of Encounter: .75
6. Installation Time: 5½ Squad Hours
7. Bill of Materials:

	DODIC	WEIGHT	CUBE
44 ea. M-21 AT Mines	K181	999 lbs.	45.7 ft^3
8 ea. M-16 AP Mines	K092	90 lbs.	1.6 ft^3
800 meters Barbed Wire		183 lbs.	1.9 ft^3
19 ea. Minefield Signs		8 lbs.	.3 ft^3
19 ea. Long Pickets		188 lbs.	2.6 ft^3
	TOTAL	1468 lbs.	52.1 ft^3
		.73 tons	

NOTES: This minefield is used for the same purpose and in the same manner as the AMD minefield. No anti-handling devices will be employed. The utilization of M-21 mines with the M607 tilt rod fuse requires that the mine be buried to stabilize the charge.
Reporting: Reports for the BMD minefield will be the same as for the AM minefield.
Installation Procedures: (omitted)

M-34 MINEFIELD

1. Designators: Normal Minefield: CM, CMA, CMB, CMC, CMD
Reinforced Minefield: DM, DMA, DMB, DMC, DMD

2. Authority To Install: Brigade Commander (May be delegated to Task Force (Battalion) Commander for short periods)

3. Dimensions: 200, 400, 600, 800 and 1,000 x 100 meters (width x depth). Width corresponds to the designators.

4. Installation and Reload Times: Install 15 minutes
Reload 20 minutes
Pod reload at ASP 1 hour

5. Bill of Materials for Supporting Engineers:
    1 ea. Aircraft Marking Panel
    1 ea. Strobe Light (For Night Operations)

NOTES: The M-34 minefield can either be preplanned or employed as an immediate obstacle, during the battle. In either case, the actions of the supporting engineers will be the same. Normally, the installing aircraft must be within one terrain feature away from the battle, or enemy air defense must be completely suppressed.

Supporting engineers maintain communications with the aircraft, mark the aim point with a panel or strobe light and control the operation. The aircraft commander's mission sheet has aimpoint coordinates, the minefield azimuth and instrument settings for the size obstacle to be emplaced. The first mine should hit on the aim point. Figure 6 shows the available M-34 minefields. Figure 7 (omitted) provides the data necessary to preset aircraft dispensing instruments for each standard minefield.
Reporting: Engineers and the aircraft commander will both report minefield completion through command channels.
Recording: (Omitted)

Figure 6: M-34 Minefields.

Approx POE*	Length	Depth	Desig	Sorties Required	Mines Required	Notes
.5	200	100	CM	1	72	1
.5	400	100	CMA	1	88	2
.55	600	100	CMB	1	160	
.45	800	100	CMC	1	160	
.5	1000	100	CMD	2	216	3
.75	200	100	DM	1	88	4
.70	400	100	DMA	1	160	
.75	600	100	DMB	2	256	5
.75	800	100	DMC	2	360	
.75	1000	100	DMD	3	416	6

NOTES: *POE-PROBABILITY OF ENCOUNTER
1. Emplace an additional DM or CMA minefield with remaining mines.
2. Emplace an additional CM minefield with remaining mines.
3. 104 mines remain after the second sortie.
4. Emplace an additional CM minefield with remaining mines.
5. 64 mines remain after the second sortie.
6. 64 mines remain after the third sortie.

ARTILLERY DELIVERED ANTITANK MINEFIELDS

1. Designators: Normal Minefield: FLM, FHM
   Reinforced Minefield: FLMD, FHMD

2. Authority To Install:
   a. Short Self-Destruct Time - Brigade Commander (may delegate to Task Force (Battalion) Commander; for a short period of time or a specific mission).
   b. Long Self-Destruct Time - Division Commander (may delegate to Brigade Commander for a short period of time or a specific mission).

3. Dimensions: FLM & FLMD - 200x200 meters (width x depth)
   FHM & FHMD - 400x400 meters (width x depth)

4. Density: FLM - .0013 mines per square meter
   FHM - .0006 mines per square meter
   FLMD - .0025 mines per square meter
   FHMD - .0012 mines per square meter

5. Probability of Encounter: Normal Minefield - .5
   Reinforced Minefield - .75

6. Installation Time: 10 minutes (Average of All Minefields)

7. Arm Time: 3 minutes after ground impact

8. Self-Destruct Time: Short or Long (specify)

9. Bill of Materials: (Use Table 1 to determine number of rounds per standard obstacle)

	DODIC	WEIGHT	CUBE
1 ea. M741 Projectile	D509	104 lbs.	-
1 ea. M718 Projectile	D503	104 lbs.	-
1 ea. Pallet M741 Projectile (8 rds)	D509	875 lbs.	10 ft^3
1 ea. Pallet M718 Projectile (8 rds)	D503	875 lbs.	10 ft^3

Table 1: Artillery Delivered Antitank Minefields

SIZE	DESIGNATOR	SD TIME	# ROUNDS	PROJECTILE
200x200	FIM	Short	6	M741
200x200	FIM	Long	6	M718
400x400	FHM	Short	11	M741
400x400	FHM	Long	11	M718
200x200	FIMD	Short	11	M741
200x200	FIMD	Long	11	M718
400x400	FHMD	Short	22	M741
400x400	FHMD	Long	22	M718

DELIBERATE ROAD CRATER

1. Designator: AC
2. Authority To Install: Maneuver Commander, All Levels
3. Dimensions: 3x4.5x4 Meters (depth x width x length)
4. Installation Effort: 2 Squad Hours
5. Bill of Materials:

	DODIC	WEIGHT	CUBE
3 ea. 40# Shape Charges	M421	195 lbs.	5.6 ft^3
5 ea. 40# Cratering Charges	M039	260 lbs.	6.9 ft^3
3 ea. 1# Blocks of TNT	M032	3 lbs.	.1 ft^3
70 meters Det Cord	M456	5 lbs.	.2 ft^3
12 meters Time Fuse	M670		
9 ea. Non-electric Caps	M131	3 lbs.	.2 ft^3
4 ea. Fuse Lighters	M766		
4 ea. M-15 AT Mines	K180	196 lbs.	4.8 ft^3
		662 lbs. .33 tons	17.8 ft^3

Quantities for each additional hole required (See Installation Procedures)

1 ea. 40# Shape Charge	M421
1 ea. 40# Cratering Charge	M039
1 ea. 1# Block of TNT	M032
5 meters Det Cord	M456
3 ea. Non-electric Caps	M131

Installation Procedures: (Omitted)

M-180 ROAD CRATER

1. Designator: BC
2. Authority to Install: Task Force (Battalion) Commander
3. Dimensions: 2.5x8x6 meters (depth x width x length)
4. Installation Effort: .5 Squad Hours
5. Bill Of Materials:

	DODIC	WEIGHT	CUBE
2 ea. M-180 Cratering Kits		230 lbs.	14.0 ft^3
4 ea. M-15 AT Mines	K180	196 lbs.	4.8 ft^3

6. Operating Instructions: (Omitted)

Other standard obstacles which were not used in this study have been omitted.

APPENDIX 5: TF 1-78 MECH OBSTACLE PLAN

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
BB01	NB45651740-45701741	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR		X	X	X	X	X	X	X
BM03	NB44901755-45301715-45151710-48801750	MINEFIELD	500x100m	10-ea BM	5.0	35-SH	TF 1-78 MECH						X	X	X
BC05	NB45301660-45401665	MINED CRATER FIELD	8x18m	3-ea BC	.63	1.5-SH	B/52 ENGR			X	X	X	X	X	X
BM07	NB45101600-45301565-45201560-45001595	MINEFIELD	100x350m	7-ea BM	3.5	24.5-SH	TF 1-78 MECH						X	X	X
A09	NB45451510-45501505	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
TD10	NB45051560-45051525	MINED DITCH	4x350m	4-ea TD	.52	2-SH 4-EH	B/52 ENGR					X	X	X	X
A11	NB45651410-45701405	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/52 ENGR					X	X	X	X
TD12	NB45351375-45351350	MINED DITCH	4x250m	3-ea TD	.39	2-SH 3-EH	B/52 ENGR					X	X	X	X
IO13	NB45151235-45201230	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
IO15	NB45551110-45601105	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
A17	NB45651040-45701035	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
TD18	NB45351085-45351060	MINED DITCH	4x250m	3-ea TD	.39	2-SH 3-EH	B/52 ENGR					X	X	X	X
CMB19	NB44601650-44751650-44801600-44651600	MINEFIELD	100x600m	1-ea CMB	.28	.25-HH	52D AVN BN							X	X
TD20	NB[illegible]251685-44301650	MINED DITCH	4x350m	4-ea TD	.52	2-SH 4-EH	B/52D ENGR					X	X	X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE SIZE[1]	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
A21	NB44601480-44601475	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
AC23	NB44301405-44351405	MINED CRATER FIELD	4.5x8m	2-ea AC	.66	4-SH	B/52 ENGR		X	X	X	X	X	X	X
BC25	NB45001365-45001375	MINED CRATER FIELD	8x18m	4-ea BC	.84	2-SH	B/52 ENGR	/		X	X	X	X	X	X
BMD27	NB44751400-44851395-44851375-44751380	MINEFIELD	100x250m	5-ea BMD	3.65	27.5-SH	TF 1-78 MECH						X	X	X
BM29	NB44101275-44201275-44201255-44101255	MINEFIELD	100x200m	4-ea BM	2.0	14-SH	TF 1-78 MECH						X	X	X
AC31	NB44301110-44351110	MINED CRATER FIELD	4.5x12m	3-ea AC	.99	6-SH	B/52 ENGR		X	X	X	X	X	X	X
BM33	NB44801140-44901135-44801120-44751125	MINEFIELD	100x150m	3-ea BM	1.5	10.5-SH	TF 1-78MECH						X	X	X
A35	NB44651030-44751030	MINED GENERAL MASS OBSTACLE	12x60m	2-ea A	.56	4-SH	B/500 ENGR					X	X	X	X
IO37	NB43701630-43701625	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
DMA39	NB43751440-43901405-43751405-43651435	MINEFIELD	100x400m	1-ea DMA	.28	.25-HH	52D AVN BN							X	X
TD40	NB43351470-43651465	MINED DITCH	4x350m	4-ea TD	.52	2-SH 4-EH	B/52D ENGR					X	X	X	X
BB41	NB43401400-43401390	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR		X	X	X	X	X	X	X
DM43	NB43051290-43201295-43201270-43051275	MINEFIELD	100x200m	1-ea DM	.15	.25-HH	52D AVN BN							X	X
DMB45	NB42601690-42701700-43051655-42951650-	MINEFIELD	100x600m	1-ea DMB	.50	.5-HH	52D AVN BN							X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE 1	2	3	4	5	6	7
A47	NB42951580-43001580	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR				X	X	X	X
BB49	NB42151560-42151570	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR	X	X	X	X	X	X	X
CMA51	NB42001585-42251560-42201550-41901575	MINEFIELD	100x400m	1-ea CMA	.15	.25-AH	52D AVN BN						X	X
BM53	NB42801485-42901490-42901445-43001450	MINEFIELD	100x400m	8-ea BM	4.0	28-SH	TF 1-78 MECH					X	X	X
FIMD55	NB42201450-42351455-42301415-42451420	MINEFIELD	200x400m	2-ea FIMD	1.14	.17-BH	52D ARTY							X
AB57	NB42501375-42501380	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR	X	X	X	X	X	X	X
DMB59	NB42901245-43001230-42651195-42701180	MINEFIELD	100x600m	1-ea DMB	.50	.5-HH	52D AVN BN						X	X
BC61	NB42501190-42501195	MINED CRATER FIELD	8x18m	3-ea BC	.63	1.5-SH	B/52D ENGR		X	X	X	X	X	X
BB63	NB42651165-42701165	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR	X	X	X	X	X	X	X
TD64	NB42301120-42451115	MINED DITCH	4x200m	2-ea TD	.26	2-SH 2-EH	B/52D ENGR				X	X	X	X
AB65	NB41951630-41951635	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR	X	X	X	X	X	X	X
TD66	NB41851705-42001665	MINED DITCH	4x400m	4-ea TD	.52	2-SH 4-EH	B/52D ENGR				X	X	X	X
FIM67	NB41001575-41201575-41201555-41001555	MINEFIELD	200x200m	1-ea FIM	.31	.17-BH	52D ARTY							X
AB69	NB15601495-15651495	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR	X	X	X	X	X	X	X
BC71	NB15351490-15351495	MINED CRATER FIELD	8x12m	2-ea BC	.42	1-SH	B/52D ENGR		X	X	X	X	X	X
BC73	NB41851235-41851240	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR		X	X	X	X	X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
FLMD 75	NB41801260-42001230-41851225-41651255	MINEFI_LD	200x400m	2-ea FLMD	1.14	.17-BH	52D ARTY								X
BC77	NB41451195-41451200	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR			X	X	X	X	X	X
BC79	NB41601140-41651140	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR			X	X	X	X	X	X
IO81	NB40951645-40951650	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
DMB83	NB40351565-40501565-40501515-40651515	MINEFIELD	100x600m	1-ea DMB	.5	.5-HH	52D AVN BN							X	X
AB85	NB40201425-40201430	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR		X	X	X	X	X	X	X
DB87	NB40001400-40051400	MINED RAVINE	10x20m	6-ea A	1.68	12-SH	B/500 ENGR		X	X	X	X	X	X	X
TD88	NB40851480-41001460	MINED DITCH	4x300m	3-ea TD	.39	2-SH 4-EH	B/52D ENGR					X	X	X	X
BB89	NB40051395-40101395	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR		X	X	X	X	X	X	X
BB91	NB40451360-40501360	MINED RAVINE	20x20m	4-ea A	1.12	8-SH	B/500 ENGR		X	X	X	X	X	X	X
AB93	NB40201345-40251345	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR		X	X	X	X	X	X	X
BC95	NB40101280-40151280	MINED CRATER FIELD	8x12m	2-ea BC	.42	1-SH	B/52D ENGR			X	X	X	X	X	X
FLM97	NB40001300-40201300-40201260-40001260	MINEFIELD	200x400m	2-ea FLM	.62	.17-BH	52D ARTY								X
BC99	NB40851255-40901255	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR			X	X	X	X	X	X
BC100	NB40901210-40951210	MINED CRATER FIELD	8x12m	2-ea BC	.42	1-SH	B/52D ENGR			X	X	X	X	X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
CMB101	NB40851220-41001220-41001155-40851155	MINEFIELD	100x600m	1-ea CMB	.28	.25-HH	52D AVN BN							X	X
TD102	NB40551110-40451095	MINED DITCH	4x200m	2-ea TD	.26	2-SH 2-EH	B/52D ENGR					X	X	X	X
IO103	NB39751620-39751625	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
DMA105	NB39401565-39551565-39551515-39401515	MINEFIELD	100x400m	1-ea DMA	.28	.25-HH	52D AVN BN							X	X
TD106	NB39151530-39001520	MINED DITCH	4x200m	2-ea TD	.26	2-SH 2-EH	B/52D ENGR					X	X	X	X
AC107	NB39501490-39551490	MINED CRATER FIELD	4.5x8m	2-ea AC	.66	4-SH	B/52D ENGR		X	X	X	X	X	X	X
FIM109	NB39501500-39601485-39251470-39201420-39001420-39051480	MINEFIELD	200x1000m	5-ea FIM	1.55	.17-BH	52D ARTY								X
BC111	NB39101415-39101420	MINED CRATER	8x30m	5-ea BC	1.05	2.5-SH	B/52D ENGR			X	X	X	X	X	X
AB113	NB39701310-39701315	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR		X	X	X	X	X	X	X
AB115	NB39701300-39701305	MINED RAVINE	10x20m	2-ea A	.56	4-SH	B/500 ENGR		X	X	X	X	X	X	X
AC117	NB39351245-39351250	MINED CRATER FIELD	4.5x8m	2-ea AC	.66	4-SH	B/52D ENGR		X	X	X	X	X	X	X
BC119	NB39401255-39401260	MINED CRATER FIELD	8x12m	2-ea BC	.42	1-SH	B/52D ENGR			X	X	X	X	X	X
FIM121	NB39251275-39451270-39551235-39401230	MINEFIELD	200x400	2-ea FIM	.62	.17-BH	52D ARTY								X
IO123	NB39751155-39751160	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
CMB125	NB38301585-38451585-38651530-38501525	MINEFIELD	100x600m	1-ea CMB	.28	.25-HH	52D AVN BN							X	X
TD126	NB38701510-38651495	MINED DITCH	4x200m	2-ea TD	.26	2-SH 2-EH	B/52D ENGR					X	X	X	X
BC127	NB39501460-38501455	MINED CRA[illegible]R FIELD	8x30m	5-ea BC	1.05	2.5-SH	B/52D ENGR			X	X	X	X	X	X
AC129	NB38401425-38401420	MINED CRATER FIELD	4.5x8m	2-ea AC	.66	4-SH	B/52D ENGR		X	X	X	X	X	X	X
AC131	NB38401405-38401400	MINED CRATER FIELD	4.5x8m	2-ea AC	.66	4-SH	B/52D ENGR		X	X	X	X	X	X	X
FIM133	NB38351450-38501445-38401420-38451380-38251380-38201420	MINEFIELD	200x800m	4-ea FIM	1.24	.17-BH	52D ARTY								X
AC135	NB38001360-38001355	MINED CRATER FIELD	4.5x12m	3-ea AC	.99	6-SH	B/52D ENGR		X	X	X	X	X	X	X
BM137	NB38101370-38201375-38251350-38151345	MINEFIELD	100x250m	5-ea BM	2.5	17.5-SH	TF 1-78 MECH						X	X	X
BC139	NB38201275-38201280	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR			X	X	X	X	X	X
DB141	NB38051220-38051225	MINED RAVINE	10x20m	6-ea A	1.68	12-SH	B/500 ENGR		X	X	X	X	X	X	X
CMB143	NB38201230-38451190-38351185-38101225	MINEFIELD	100x600m	1-ea CMB	.28	.25-HH	52D AVN BN							X	X
A145	NB37501630-37551630	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
BC147	NB37401440-37401445	MINED CRATER FIELD	8x24m	4-ea BC	.84	2-SH	B/52D ENGR			X	X	X	X	X	X
DMC149	NB37251445-37401455-37751380-37751385	MINEFIELD	100x800m	1-ea DMC	.63	.5-HH	52D AVN BN							X	X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE	1	2	3	4	5	6	7
TD150	NB37951480-37801465	MINED DITCH	4x200m	2-ea TD	.26	2-SH 2-EH	B/52D ENGR					X	X	X	X
FLM151	NB37301320-37451330-37651295-37501285	MINEFIELD	200x400m	2-ea FLM	.62	.17-BH	52D ARTY								X
TD152	NB37151350-37201325	MINED DITCH	4x250m	3-ea TD	.39	2-SH 3-EH	B/52D ENGR					X	X	X	X
AC153	NB37401235-37451235	MINED CRATER FIELD	4.5x12m	3-ea AC	.99	6-SH	B/52D ENGR		X	X	X	X	X	X	X
BM155	NB37351240-37451235-37401210-37251215	MINEFIELD	100x250m	3-ea BM	1.5	10.5-SH	TF 1-78 MECH						X	X	X
A157	NB36151640-36201640	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
IO159	NB36951605-36951600	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
AC161	NB36601520-36601525	MINED CRATER FIELD	4.5x16m	4-ea AC	1.32	8-SH	B/52D ENGR		X	X	X	X	X	X	X
FLM163	NB36801525-36901520-36851500-36751505	MINEFIELD	200x200m	1-ea FLM	.62	.17-BH	52D ARTY								X
IO165	NB36651465-36651470	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH				X	X	X	X	X
BC167	NB36701445-36701450	MINED CRATER FIELD	8x36m	6-ea BC	1.26	3-SH	B/52D ENGR			X	X	X	X	X	X
DMA169	NB36951440-37101435-36801400-36701405	MINEFIELD	100x400m	1-ea DMA	.28	.25-HH	52D AVN BN							X	X
A171	NB36451380-36451385	MINED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/500 ENGR					X	X	X	X
FLM173	NB36551370-36651375-36801345-36701340	MINEFIELD	200x400m	2-ea FLM	.62	.17-BH	52D ARTY								X

TGT #	GRID	COMPUTER DESIGNATION	OBSTACLE[1] SIZE	STD OBS	MATERIAL[2]	EFFORT[3]	UNIT ASSIGNED	COMPUTER RUNS BASE 1 2 3 4 5 6 7
IO175	NB36351275-36351280	MINED FIXED WALL	4x16m	1-ea IO	.16	4-SH	TF 1-78 MECH	X X X X X
CMA177	NB36851230-37001225-36951190-36801190	MINEFIELD	100x400m	1-ea CMA	.15	.25-HH	52D AVN BN	X X
BM179	NB35601545-35701545-35701525-35601525	MINEFIELD	100x200m	4-ea BM	2.0	7-SH	B/52D ENGR	X X X
BC181	NB35951430-35951435	MINED CRATER FIELD	8x30m	5-ea BC	1.05	2.5-SH	B/52D ENGR	X X X X X X
AC183	NB36001420-36001425	MINED CRATER FIELD	4.5x16m	4-ea AC	1.32	8-SH	B/52D ENGR	X X X X X X X
FIMD185	NB358[illegible]40-36001440-3600[illegible]420-35801420	MINEFIELD	200x200m	1-ea FIMD	1.14	.17-BH	52D ARTY	X
BM187	NB35901420-36001410-35901405-35851415	MINEFIELD	100x150m	3-ea BM	1.5	10.5-SH	B/500 ENGR	X X X
A189	NB35551290-35551295	MIXED GENERAL MASS OBSTACLE	12x30m	1-ea A	.28	2-SH	B/52D ENGR	X X X X
BM191	NB35451250-35551250-35551235-35451235	MINEFIELD	100x150m	3-ea [illegible]M	1.5	10.5-SH	B/52D ENGR	X X X
110 ea				291 ea	88.41 ST	465-SH 39-EH 4.5-HH 1.87-BH		TOTALS

NOTES: 1. Obstacle size is shown after execution, in meters.

2. Material quantity is in short tons.

3. Effort is measured in squad (SH), equipment (EH), helicopter (HH), and battery (BH) hours. The maximum time for a battery to install any obstacle is .17 hours.

TAB A NOTES TO APPENDIX 5

TF 1-78 MECH OBSTACLE PLAN

The following data and assumptions apply to all work estimates in tabs B through G of Appendix 5.

1. Thirty-six (36) hours of battlefield preparation time is available before the enemy crosses the Inter-Zonal Border (IZB).

2. Only twenty-eight (28) of the available 36 hours have been used in the work schedules. H-hour on the following tabs. The remaining eight (8) hours have been allocated to equipment maintenance.

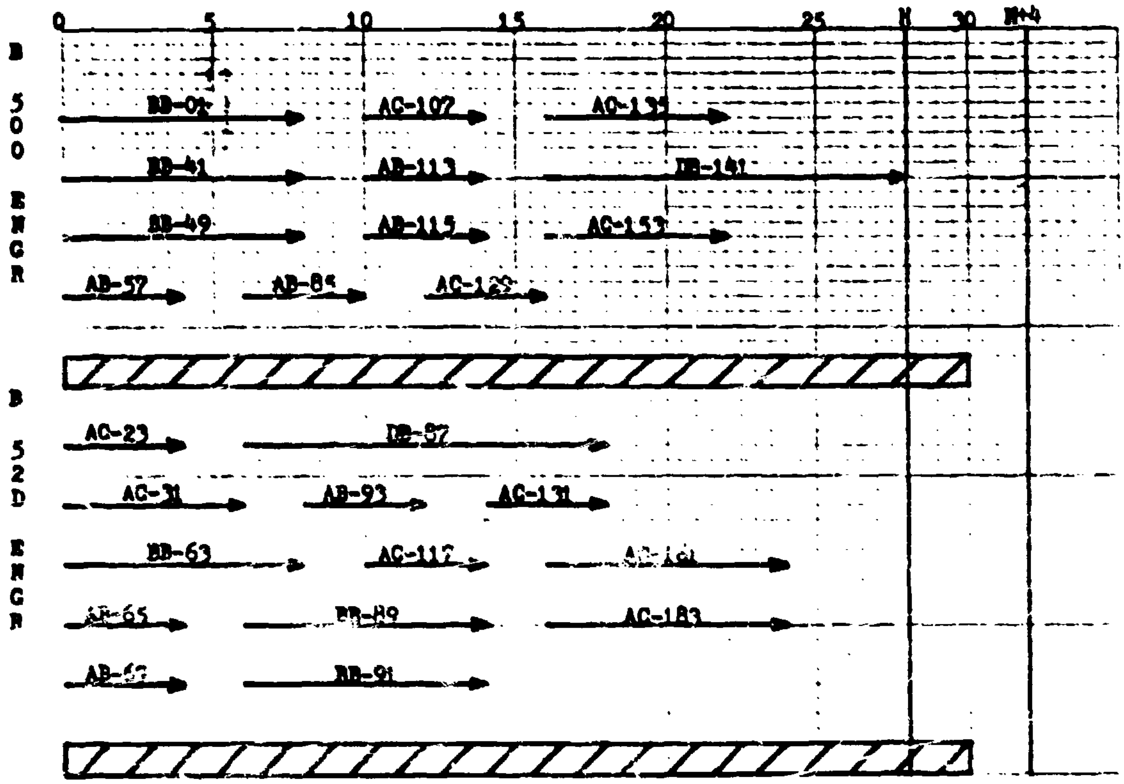
3. Four (4) additional hours of battlefield preparation time are available in the TF 1-78 MECH sector while the battle is fought between the IZB and PL Yellow. H + 4 on the following tabs.

4. Each block on the following bar graphs is equal to one half (.5) hour. An obstacle preceeded by a parenthesis (3) indicates the number of squads working on the obstacle. Obstacles without a ( ) are installed by one squad.

5. Some obstacles are executed immediately. Others are transferred to maneuver units for subsequent execution. Engineer units do not guard obstacles.

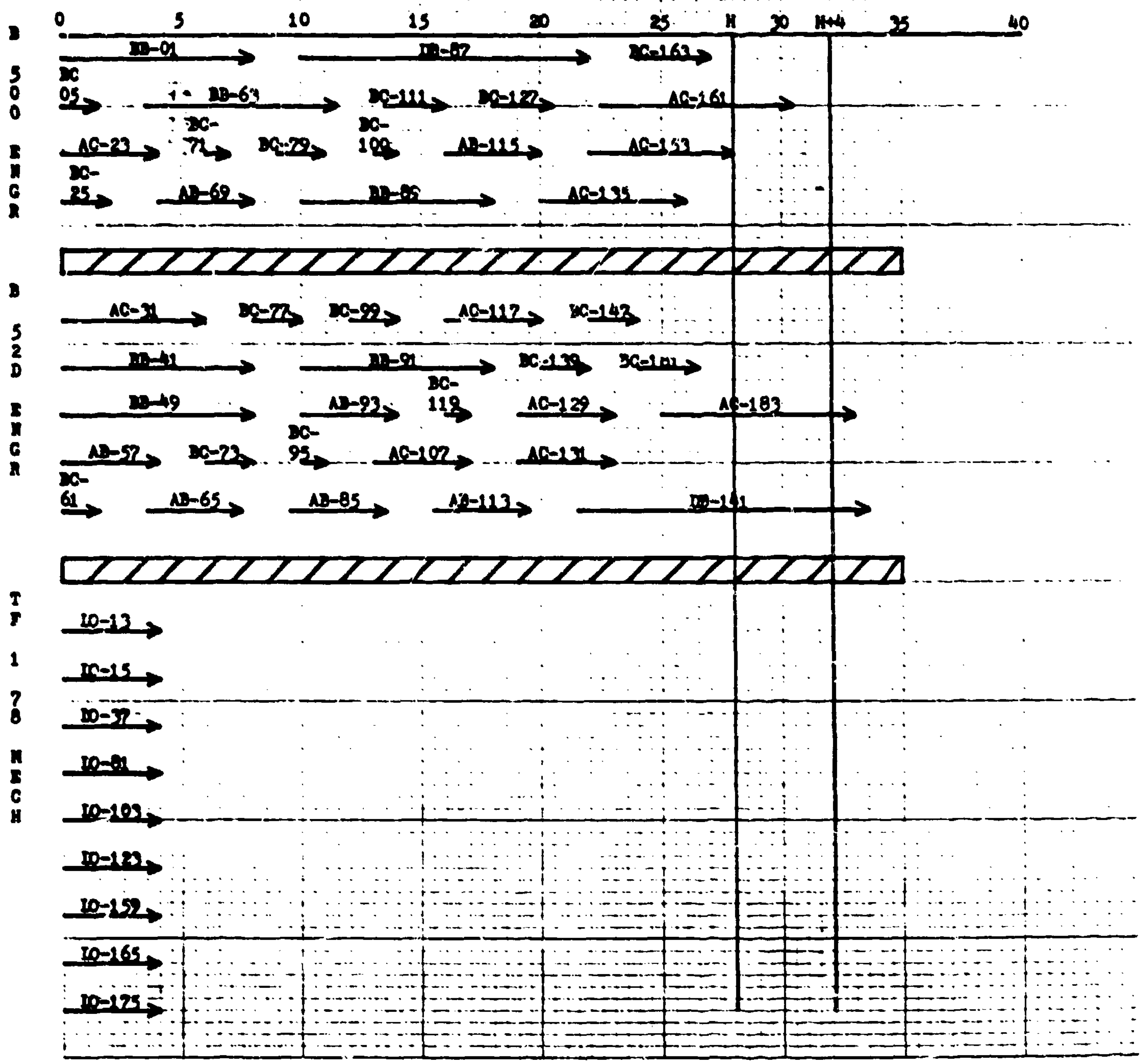
TAB B WORK SCHEDULE TO APPENDIX 5 TF 1-78 MECH

OBSTACLE PLAN

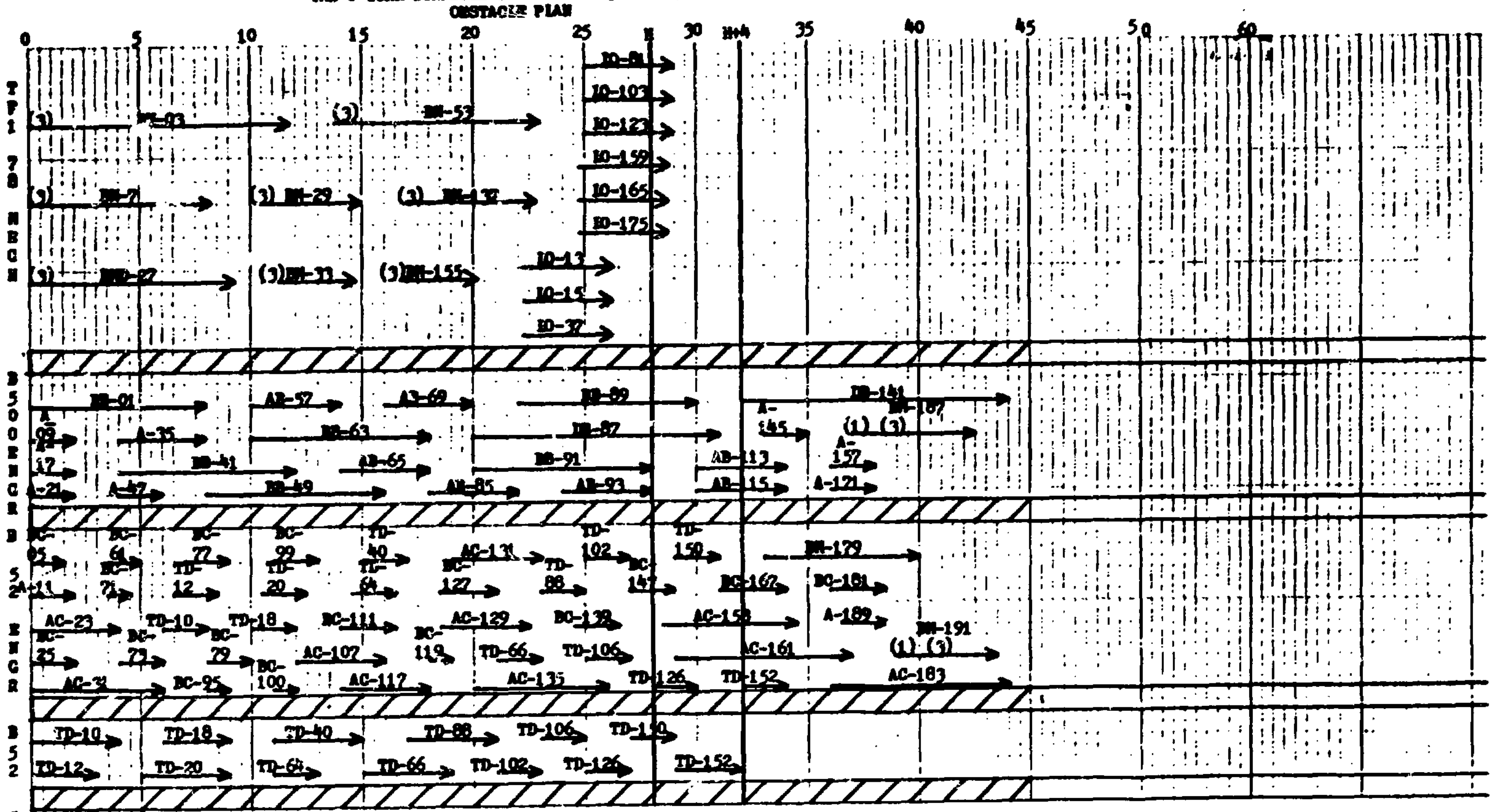


TAB D WORK SCHEDULE TO APPENDIX 5 TF 1-78 MECH

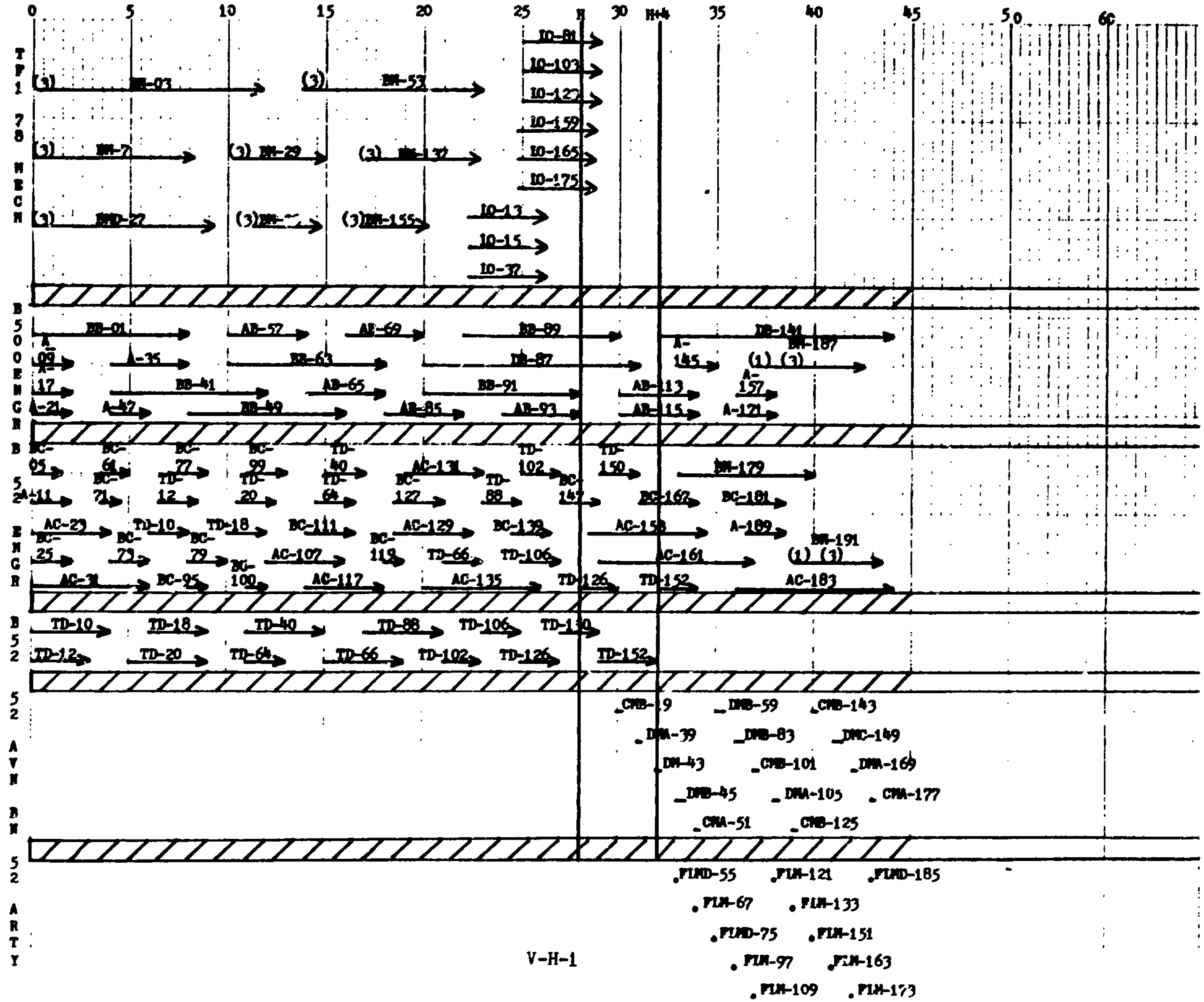
OBSTACLE PLAN

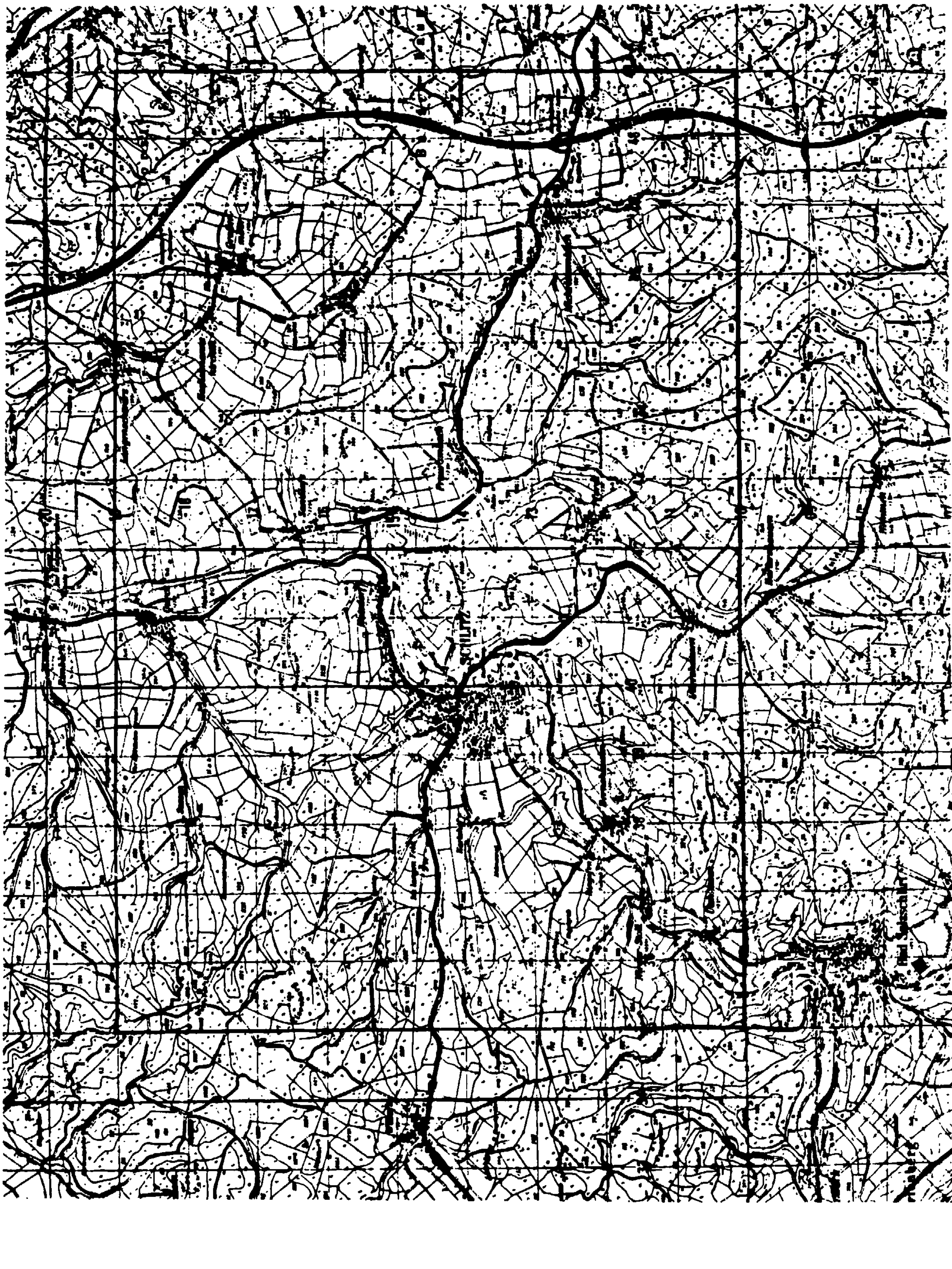


TAB F WORK SCHEDULE TO APPENDIX 5 TF 1-78 MECH OBSTACLE PLAN

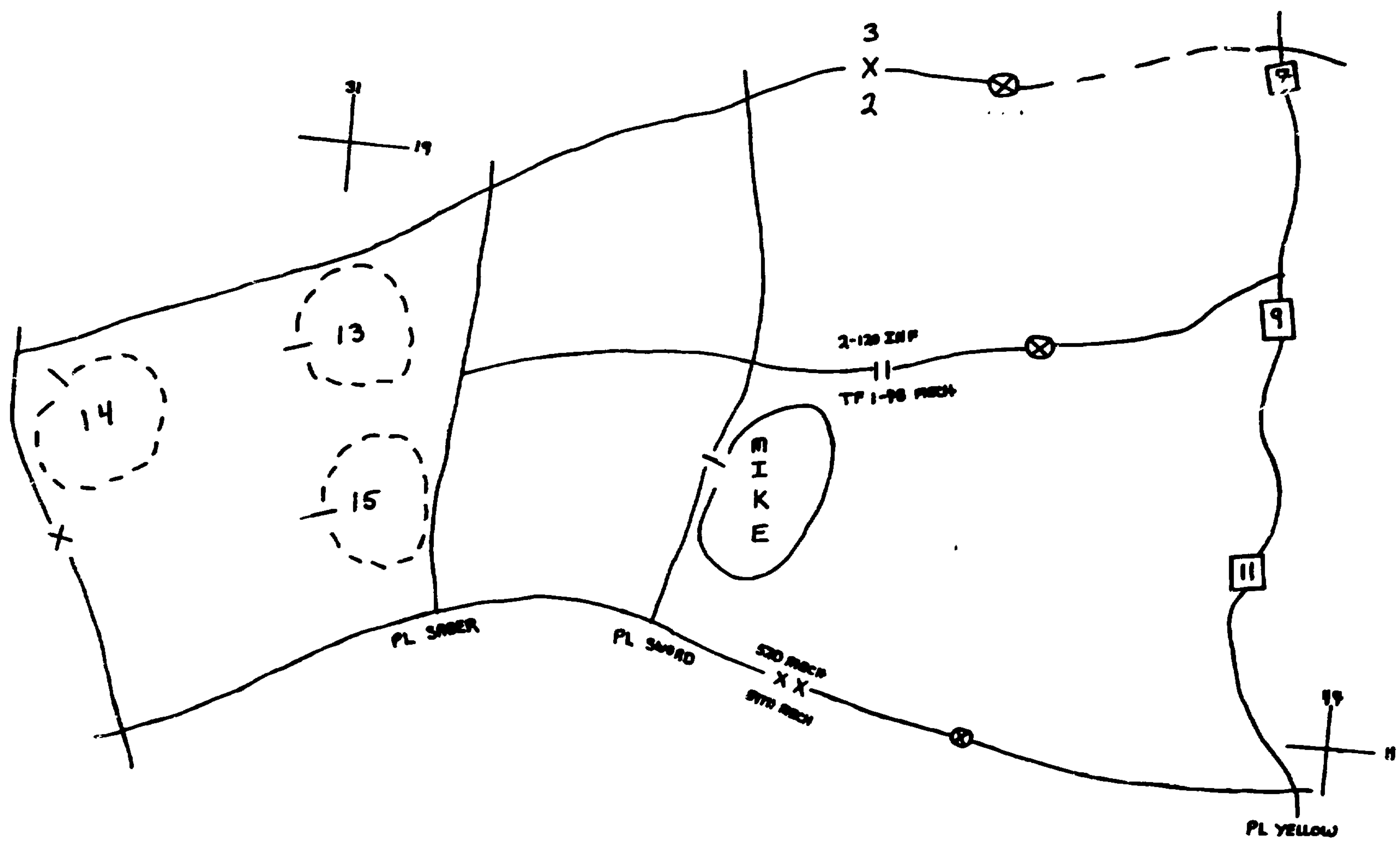


TAB E WORK SCHEDULE TO APPENDIX 5 TF 1-78 MECH
OBSTACLE PLAN

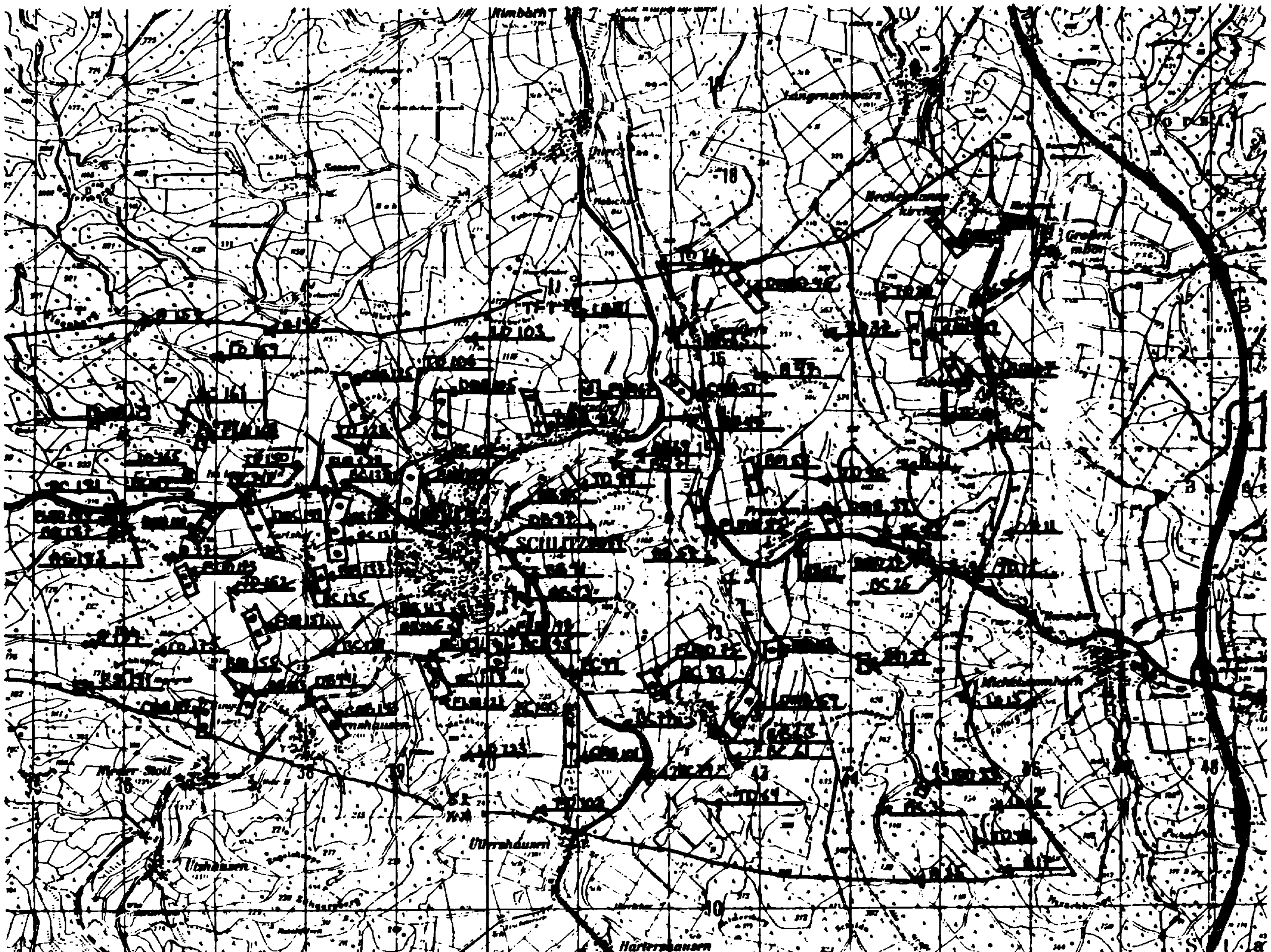




MAP-1



3
X
2
31
19
2-120 INF
TF 1-98 MECH
13
14
15
MIKE
9
11
PL SABER
PL SWORD
PL YELLOW
11



MAP-2